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UNIVERSITY OF SZEGED FACULTY OF ENGINEERING
H-6724 Szeged, Mars tér 7.
Phone: +36 (62)546 000

CONTENTS

RECOVERY OF PROTEINS FROM DAIRY EFFLUENTS BY MEANS OF ULTRAFILTRATION

Rafael Camarillo, Isaac Asencio, Jesusa Rincón*
Departamento de Ingeniería Química, Facultad de Ciencias del Medio Ambiente, Universidad de Castilla-La Mancha. Av. Carlos III, s/n. 45071 Toledo, Spain.
Phone: +34 925 268800; Fax: +34 925 268840.
* Corresponding author: e-mail: Rafael.Camarillo@uclm.es

ABSTRACT

The purpose of this work was to investigate the potential of membrane ultrafiltration for the recovery of proteins from dairy effluents. Employing a 10 kDa tubular ceramic membrane in total recycle and batch modes, the effects of temperature, feed flow rate, and protein concentration in feed were evaluated by measuring permeate flux-transmembrane pressure and permeate flux-time profiles, and total protein rejection coefficients. Results from these experiments have been used to analyze the technical viability of the recovery of dairy proteins by ultrafiltration. Last stage of the work consisted of a preliminary analysis of different phenomena limiting flux in this system. For this reason, previous experimental data were fitted with mathematical models proposed in bibliography by means of a computer tool of our own programming. Furthermore, a thermo-chemical washing method was successfully applied to clean tubular ceramic membranes previously fouled with dairy solutes.

Keywords: Milk proteins; Ceramic membrane; Ultrafiltration.

1. INTRODUCTION

Present study places inside a very recent research line of the Department of Chemical Engineering in the Faculty of Environmental Sciences of University of Castilla-La Mancha (Spain) about reclamation of dairy effluents by means of ceramic tubular membranes.

Milk can be considered as an emulsion of fat globules in an aqueous phase. The aqueous phase consists of suspended and dissolved components, such as casein micelles, serum proteins, lactose and salts. Besides the major components (fat, casein and lactose), milk contains valuable minor components that can be interesting for their specific isolation (Brans et al 2004). Molecular weights and sizes of the components of a typical whole milk are shown in Table 1.

The dairy industry was pioneer in the development of ultrafiltration (UF) equipments and techniques to fractionate the proteins from whey and to make cheese from ultrafiltered milk. Application of UF in the dairy industry started with the separation and concentration of whey proteins from whey in 1972 (Atra et al 2005).

Table 1. Molecular sizes of milk components (Cheryan and Alvarez 1995).

Component	Molecular weight (Da)	Diameter (nm)
Water	18	0.3
Chloride ion	35	0.4
Calcium ion	40	0.4
Lactose	342	0.8
α-lactalbumin	14,500	3
β-lactoglobulin	18,000	4
Bovine Serum Albumin	69,000	5
Casein micelles (milk protein in solution)	107,000-109,000	25-130
Fat	-	2,000-10,000

Whey is the liquid remaining after the recovery of cheese. Whey contains more than the half of the solids of the original whole milk, including whey protein (20 % of total protein) and most of the lactose, minerals and water-soluble vitamins. The principal aim of UF of whey is to concentrate the native or pre-denatured whey proteins in order to obtain a whey protein powder with varying protein content and reduced lactose and ash contents (Da Costa et al 1993, Huffman 1996).

In UF the constituents of milk are fractionated according to molecular size. Depending on the retention characteristics of the membranes there can be a significant difference in the nutritive power of the retentate and permeate. The protein and fat fractions are retained very well (virtually completely) in the retentate, while the lactose, minerals and vitamins are divided between the retentate and the permeate (Hinrichs 2001).

UF has been as well used to recover valuable components from dairy waste streams (Khider et al 2004, Rektor and Vatai 2004). For example, dairy proteins are valuable products and are used as high-value food additives, nutraceuticals and therapeutics (Chollangi and Hossain 2007).

Unfortunately, current membrane processes for milk have a rather low capacity due to the strong flux decline by fouling. These processes are usually energy demanding because of the high cross-flow velocity that is required to control fouling (Brans et al 2004).

Fouling of UF membranes in the dairy industry is mostly due to precipitation of micro organisms, proteins, fats and minerals on the membrane surface. Formation of a cake or gel on the membrane surface or into the membrane pores increases fouling due to the fact that present pores are (partially) blocked or become narrow, and finally this reduces the permeate flux (Kazeminoghadam and Mohammadi, 2007). Calcium phosphate is the predominant foulant at various fouling conditions, with other components including whey protein and lactose playing a lesser role. This is evidenced by the trends in bulk and soluble calcium concentration during filtration. pH value has been also shown to have a

greater influence on flux decline than temperature, with high fouling observed for conditions of high pH values (Rice et al 2006).

Due to fouling, cleaning of the membranes is essential (Chollangi and Hossain 2007). Cleaning can be usually performed in 3 forms: physical, chemical and biological (Trägardh 1989). Chemical methods are used most often. Chemical cleaning agents must be able to dissolve most of the precipitated materials and take them away while they should not damage the membrane surface (Lindau and Jönsson 1994). Some of these cleaning agents are acids, alkalis, surfactants, disinfectants and combined cleaning materials (Trägardh 1989). While using these materials as cleaners, the effect of some parameters such as pH, concentration and washing time (Lindau and Jönsson 1994) and operating conditions like cross-flow velocity, transmembrane pressure and temperature (Bohner and Bardley 1992, Daufin et al 1991) must be considered. In order to clean the membranes fouled with milk and whey, one alkali washing step followed by an acid washing step has been suggested (Daufin et al 1991), and to get better results one enzyme washing step could be used before chemical washing.

The aim of this research work was to study the effects of temperature, feed flow rate and protein concentration in feed on the recovery of milk proteins from synthetic diluted effluents from dairy industry. Different phenomena limiting permeate flux were analysed, and a method of chemical cleaning was tried. The use of tubular ceramic membranes is another novelty with regard to existing research, since a majority of studies of this kind at lab scale were developed with polymeric flat membranes (Atra et al 2005, Chollangi and Hossain 2007, Kazeminoghadam and Mohammadi 2007, Rabiller-Baudry et al 2007, Rice et al 2006), while operation at industrial scale is usually performed with ceramic membranes, because of better resistance of these membranes against cleaning and disinfection (Brans et al 2004).

2. MATERIALS AND METHODS

2.1. Fluids and cleaning procedure

Synthetic milk effluents were prepared with a solution of commercial whole cow milk powder (UHT, Central Lechera Asturiana, Spain). Total protein quantification in permeate and retentate streams was performed using the well-known *Biuret's method* (Gornall et al 1949).

After each experiment with milk solution, the membrane was thermo-chemically cleaned with an alkaline solution (NaOH 0.125 M; T = 75 °C; cross-flow velocity, v = 2 m/s; transmembrane pressure, TMP = 2 bar; 60 min) in first place, and then with an acid one (HNO_3 0.1 M, T = 50 °C, v = 2 m/s, TMP = 2 bar, 45 min), until the clean membrane resistance was recovered. Rinsing stages with distilled water (T=25 °C, v=3 m/s, TMP=0 bar, 20 min) were inserted before and after alkaline cleaning, and after acid cleaning.

2.2. Set-up

A laboratory-scale installation was used for UF experiments. This installation consisted of a 2 litres jacketed glass tank (1), a Liquiflo 37 F gear pump (2), a Selecta Frigiterm-10 circulation ultrathermostat (3), a Techfluid flowmeter (60-630 l/h) (4), a Novasep Micro Carbosep 40 module with a Carbosep M5 tubular membrane (zirconia, MWCO 10,000 Da,

$8 \cdot 10^{-3}$ m^2, internal diameter $6 \cdot 10^{-4}$ m, 0.4 m length) (5), two Bourdon manometers (6) and a needle valve (7). A diagram of this installation is pictured in Figure 1.

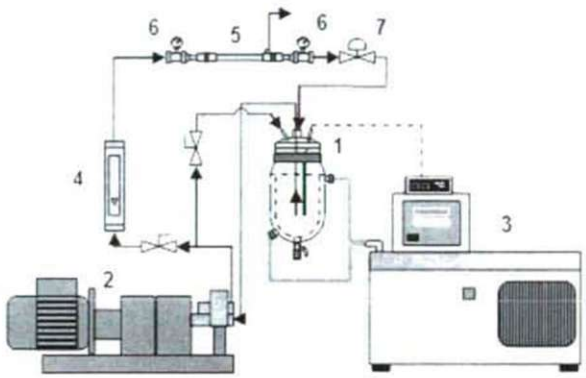

Fig.1. Diagram of installation of UF.

3. RESULTS AND DISCUSSION

3.1. Total recycle experiments

For the first time, influence of temperature, protein concentration in feed and feed flow rate on permeate flux and total protein rejection coefficients were analyzed by total recycle (constant composition) experiments, in which retentate and permeate were continuously returned to the feed tank.

Some results from these experiments are depicted in Figures 2 and 3. As can be deduced from these plots, three different measures can be performed in order to improve permeate flux: an increase in temperature, a decrease in protein concentration in feed and/or an increase in feed flow rate.

The effect of temperature on the permeate flux can be understood from its effect on the properties of the feed stream. Increasing the temperature results in a decrease in the viscosity of milk, resulting in an increase in permeate flow rate according to Hagen-Poiseuille law (Chollangi and Hossain 2007, Rice et al 2006). Nevertheless, operating temperature should not be higher than 50 °C, because it can cause heat denaturation of the whey proteins (Atra et al 2005).

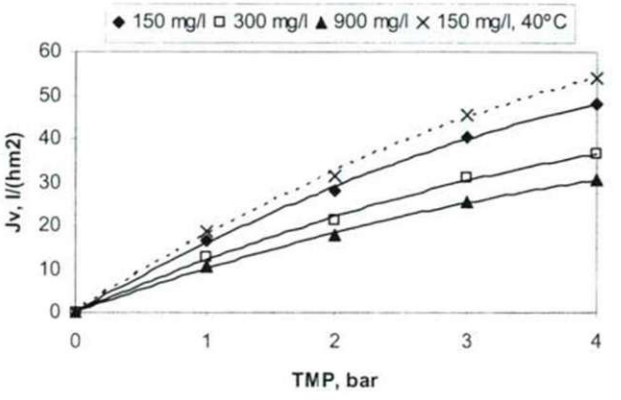

Fig. 2. Permeate flux profiles at v=1 m/s, at different protein concentrations in feed stream (— 25°C, ---- 40 °C).

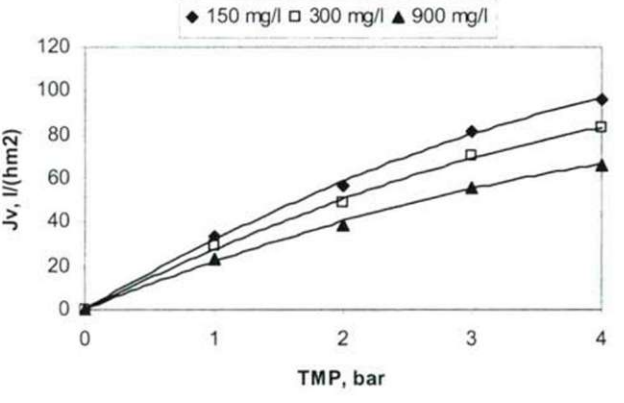

Fig. 3. Permeate flux profiles at v=3 m/s, temperature 25 °C at different protein concentrations in feed stream.

For all protein concentrations essayed, it is observed that the permeate flux increased up linearly to a transmembrane pressure of 2-3 bar, after that it reached a plateau when the TMP increased from 3 to 4 bar. This could be attributed to the gradual build-up of protein and similar molecules on the membrane surface nullifying the effect of an increase in pressure (Chollangi and Hossain 2007). The higher concentration of protein in the milk systems seems to promote concentration polarization which controls permeate flux (Ramachandra Rao 2002). Above a critical TMP (3-4 bar) the flux becomes almost independent of pressure, because the protein molecules deposited on the surface of the membrane cause a concentration polarization controlled by two factors, the type of membrane and the cross-flow velocity (Atra et al 2005).

In this way, in Figures 2 and 3 we can see that as cross-flow velocity increases, concentration polarization decreases, hence the point of pressure independence advances to

higher pressures (TMP 2 bar at v=1 m/s, TMP 3 bar at v=3 m/s). This phenomenon is in agreement with literature data (Kessler 2002). Higher flow rate at the membrane surface is a very important factor in increasing permeate flux. Using higher velocity the deposited molecules are continuously removed from the membrane surface and thus the hydraulic resistance of the fouling layer is reduced.

There are different methods which can be used to generate high turbulence: increasing the feed flow rate, decreasing the flow channel dimensions or insertion of a static mixer (Atra et al 2005). It is obvious that the flux increases at higher cross-flow velocities because there is a decrease in the deposit layer resistance. Continued gain in flux is limited by energy, which can be afforded in pumping, but we must take into consideration that there is the danger of damaging the fat globules by excessive pumping.

The trends observed in Figures 2 and 3 can be also related to the concept of "critical" flux. It is the upper flux to obtain reversible deposit of foulant on a membrane, and it was proposed in the early 1990s' (Field et al 1995). A more practical concept of "sustainable" flux was more recently defined as the upper flux to obtain reversible deposit on a constant fouling layer (Bacchin et al 2005, Manttari et al 1997).

According to the "critical" flux theory (Field et al 1995, Howell 1995), three regimes can be distinguished for membrane filtration, according to transmembrane pressure dependence of flux. In regime I, the transmembrane pressure is below the critical pressure and there is cake free filtration. Two forms of critical flux exist: the hard form, where the flux/pressure relation is linear and equal to the clean water flux; and the weak form, where the flux/pressure relationship is still linear, but lower than for clean water flux. Filtration in this regime is advised to obtain optimal selectivity. However, because of the low value of the flux, the capacity is low and a large membrane area is needed. According to Figures 2 and 3, this is the regime of operation for the totality of experiments under TMP 2 bar for v=1 m/s and under TMP 3 bar for v=3 m/s.

In regime II, the transmembrane pressure is above the critical pressure and flux is equal to the limiting flux, which can be described by the gel filtration model or back-transport models (Belfort et al 1994), as the transport of materials towards the membrane is in equilibrium with the back transport towards the cross-flow. Hence, a higher cross-flow velocity is advantageous and could even shift the process to regime I. Furthermore, the flux is independent of the transmembrane pressure and the pore size of the membrane (Brans et al 2004). It is the case of experiments carried out at TMP higher than 2 bar for v=1 m/s, and 3 bar for v=3 m/s.

In regime III, transmembrane pressure is clearly above the critical pressure and results in a time dependent flux, mostly attributed to cake compaction. For long time stable operation in regime III, it is necessary to remove fouling after short intervals.

Concentration of whey protein usually takes place in regime II, to have optimum capacity, whereas the isolation of whey proteins is restricted to regime I, for optimal selectivity (Brans et al 2004).

Regarding total protein rejection coefficients, values within the range 0.92-0.99 were obtained in all experiments (Atra et al 2005, Chollangi and Hossain 2007), except for experiment at 40°C, where rejection coefficient decreases dramatically until 0.49.

The reason is high temperature increases the solute diffusivity and the rate of transport of solutes from the membrane surface into the permeate stream (Chollangi and Hossain 2007, Rice et al 2006). According to MWCO of membrane used and typical composition of milk (Table 1), retentate stream will be constituted by α-lactalbumin, β-lactoglobulin, BSA, casein and fat (Brans et al 2004, Chollangi and Hossain 2007).

3.2. Batch experiments. Factors limiting permeate flux.

Once viability of proposed method for the retention of milk proteins has been proved in total recycle experiments, we made use of batch experiments in order to increase protein concentration in solution to treat and to study factors limiting permeate flux. For this, influences of initial protein concentration, feed flow rate and temperature on permeate flux-time profiles (Figs. 4 and 5) and protein concentration in feed-time profiles (Figs. 6 and 7) were analyzed.

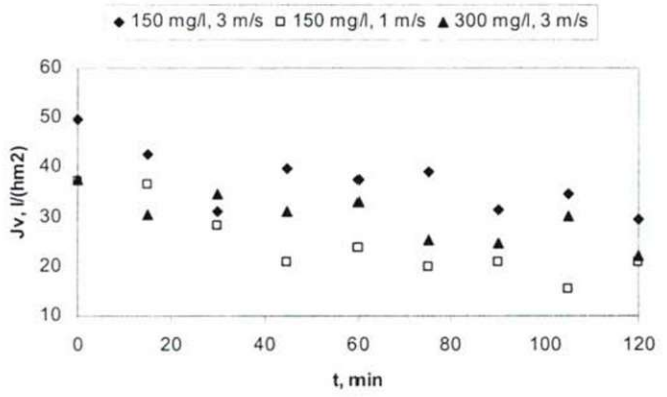

Fig. 4. Permeate flux-time profiles at temperature 25 °C, different initial protein concentrations and cross-flow velocities.

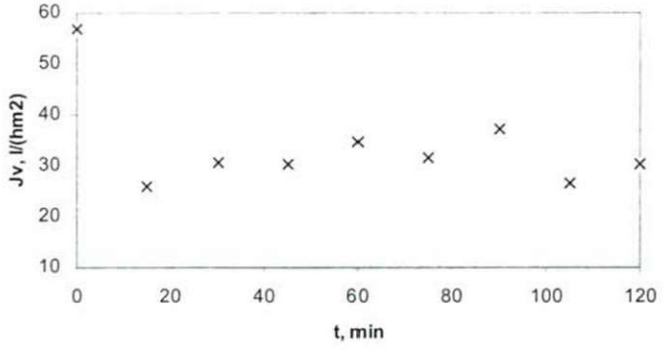

Fig. 5. Permeate flux-time profile at temperature 40 °C, initial protein concentration 150 mg/l and cross-flow velocity 3 m/s.

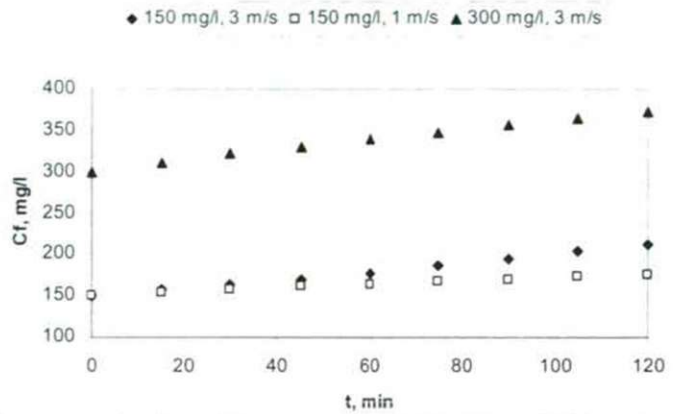

Fig. 6. Protein concentration-time profiles at temperature 25 °C, different initial protein concentrations and cross-flow velocities.

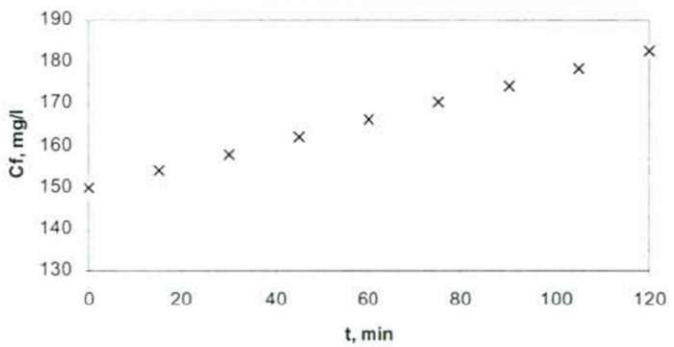

Fig. 7. Protein concentration-time profile at temperature 40 °C, initial protein concentration 150 mg/l and cross-flow velocity 3 m/s.

Generally speaking, we can observe that protein concentration is better developed in experiments with initial concentration 150-300 mg/l, v=3 m/s and 25 °C. In experiment with higher temperature (Fig. 5), initial flux is maximum but fouling appears before, and for experiment at v=1 m/s, permeate fluxes are minimum for all operation time.

In all cases the permeate flux decreases with time. This is expected as the components from the wastewater sample become more concentrated and they can be adsorbed on to the membrane surface and causes such decrease. The permeate flux seems to level off at around 30 l/h·m^2 after 60 min when v=3 m/s, and 20 l/h·m^2 when v=1 m/s. Steady state has been achieved after initial fouling because the rate of adsorption of molecules on the membrane surface is equal to the rate of molecules removal from the surface due to the cross-flow (Chollangi and Hossain 2007).

As it was aforementioned, one of the major factors influencing the economical feasibility of membrane separation technologies is the rate at which fouling occurs. Permeate flux declines due to the contribution of the various fouling processes (James et al 2003).

Different fouling mechanisms can take place: adsorption, pore blocking, cake layer formation, and depth fouling (Brans et al 2004). Concentration polarization is strictly speaking not fouling, but also decreases the flux and can affect selectivity, since rejected particles can accumulate at the surface of the membrane due to their slow diffusion back into the retentate, causing a concentration gradient at the membrane surface. The concentration at the surface can exceed that required for gel formation resulting in a gel layer. This layer alters the resistance of the membrane and, possibly, the sieving characteristics also.

Short-time reversible fouling takes place on a small time scale (seconds, Guerra et al 1997) and can be avoided by the right choice of process conditions, such as high cross-flow velocity or back-pulsing. Pore blocking and cake formation are typically considered short-time reversible fouling. Long-time reversible fouling causes a slow flux decrease in time (hours) and can be removed by stopping the production process and applying a cleaning procedure. Irreversible fouling causes flux decline and cannot be removed by cleaning (Brans et al 2004).

According to bibliography, when in feed there are low levels of proteins (as in the beginning of our batch experiments), flux is controlled by the fouling resulting from gradual adsorption of dairy proteins to the membrane surface and pore plugging by precipitated calcium phosphate (Ramachandra Rao 2002).

In some previous studies, it was checked that the pore blocking model as well as the cake model were not able to describe the fouling of membranes in UF of dairy effluents (Rabiller-Baudry et al 2007). Nevertheless, because of the relative size of membrane pores and proteins, it is obvious that fouling due to proteins mainly occurs on membrane surface and not into the pores. It is reported that apolar interactions involving proteins are responsible of the cohesion of the fouling layer (Rabiller-Baudry et al 2007).

With feeds with higher levels of proteins (as in the end of our batch experiments), the formation of a concentration polarization layer brought the initial flux to lower levels, but they reach a plateau without change during 1 h of UF run (Ramachandra Rao 2002).

For this reason, final experimental data of batch runs have been fitted according to thin film concentration polarization theory, where k is mass transfer coefficient (m/s), C_m is concentration at membrane, C_f and C_p are concentrations in feed and permeate, respectively (Cañizares et al 2002).

$$J_v = k \ln\left(\frac{C_m - C_p}{C_f - C_p}\right) \qquad (1)$$

With this equation, we have obtained values of k in the range of $1.0 \cdot 10^{-5}$ m/s (for experiment with 150 mg/l and v=3 m/s) and $2.5 \cdot 10^{-6}$ m/s (150 mg/l, v=1 m/s). In the case of experiment at 40 °C, mass transfer coefficient is similar to the corresponding experiment at 25°C, but C_m is almost twice bigger.

3.3. Cleaning process

During the ultrafiltration of dairy solutions a more or less important overall fouling happens, leading to a strong decline of permeate flux. After water rinsing, some materials which are not chemically adsorbed on the membrane surface can be washed with distilled water (Madaeni et al 2001), but long-time reversible and strong irreversible fouling remained generally on membranes. A chemical cleaning is needed in order to restore partially the flux (Rabiller-Baudri et al 2007).

According to bibliography, acids are the weakest cleaning agents for fouling with dairy effluents. Results show that alkaline solutions have a moderate effect, but combinations of chelating agent, surfactant and alkali provide the best cleaning efficiency (Kazeminoghadam and Mohammadi 2007).

In this study, we have made use of a combination of an alkali agent (sodium hydroxide 0.125 M; T = 75 °C; cross-flow velocity, v = 2 m/s; transmembrane pressure, TMP = 2 bar; 60 min) and an acid agent (nitric acid 0.1 M, T = 50 °C, v = 2 m/s, TMP = 2 bar, 45 min). Alkaline cleaning is known to be efficient toward organic matter whereas acid solution is known to be efficient toward mineral matter (Rabiller-Baudri et al 2007). Autopsy of different membranes at the end of service life in UF of dairy products (Rabiller-Baudri et al 2002) showed that proteins were the main components of the irreversible fouling and consequently the main target of the cleaning.

It seems that the cleaning agent diffuses into the deposited cake layer on the membrane surface. Diffusion rate depends on different factors including turbulence. A chemical reaction occurs between the cleaning agent and the deposited materials at the membrane surface. The reaction may be hydrolysis, dissolution or dispersion. This results in removal of fouling materials from the membrane surface (Kazeminoghadam and Mohammadi 2007).

Other reported results evidenced that water rinsing must be taken into account in the whole efficiency of the cleaning (Rabiller-Baudry et al 2007). For this reason, before both alkaline and acid cleanings, and after acid cleaning, membrane was rinsed with distilled water for 20 min (T = 25 °C, v = 3 m/s, TMP = 0 bar).

In all cases it was observed that clean membrane resistance was successfully recovered after cleaning process. Obviously, this process was only applied when pure water flux of fouled membrane was lower than the advisable value provided by membrane manufacturer (170 l/h·m^2 at TMP 4 bar and 25°C).

4. CONCLUSIONS

We can conclude that proposed UF method is viable for the recovery of proteins from diluted synthetic dairy solutions. Furthermore, according to our results, feed flow rate is the key parameter to fight against membrane fouling and concentration polarization.

Nevertheless, in order to develop future research, it would be important to analyze the influence of pH value on permeate fluxes and protein rejection coefficients.

Rice et al (2006) report that an increase in pH value and temperature decreased permeate flux, since calcium phosphate will precipitate from solution, and this precipitate will likely to settle onto the membrane in the form of a mineral cake layer.

Furthermore, adjustment of pH and addition of salt influence the electrostatic and steric interactions between different proteins, and between proteins and the membrane (Cheang and Zydney 2003).

As summary, pH value could be a good method to control membrane fouling during ultrafiltration of dairy effluents (Ramachandra Rao 2002).

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THE BREEDING OF TSIGAI SHEEP AS A POSSIBILITY TOWARDS THE PROFITABILITY II. FATTY ACID COMPOSITION OF MILK

J. Csanádi, J. Fenyvessy, I. Bajúsz
University of Szeged, Faculty of Engineering

ABSTRACT

The fatty acid composition of cow milk stands very close to Hypothetical Ideal Fatty acid composition (HIF) but sheep milk fat has nutritional advantage comparing to cow milk by bulk of references. Some of authors explain it by mainly the higher ratio of unsaturated (UFA) and C4-12 fatty acids. Moreover nowadays is very important to know the amount and the ratio of n-6 and n-3 fatty acid in our foods. Our objective was to explore the fatty acid composition of milk from milking Tsigai sheep. By our findings the physiological evaluation of FA composition of Tsigai sheep milk and its products are more favourable in every aspect than cow milk.

1. INTRODUCTION

The beneficial effect of ruminant's milk and milk product for the human health is well known. But the small differences in the milk composition can cause noticeably variance in the physiological effect. The difference between the fatty acid composition of sheep and cow milk is a good instance for it.

According to the results of some authors the fatty acid composition of the sheep milk is similar as the cow milk's one (Adrian 1973, Balatoni, Ketting 1981, Ramos, Juarez, 1984).

Others established noticeable differences regarding fatty acids comparing to the cow milk (Morrison1968, National Institute of Health 2005, Posati, Orr 1976, Sawaya, Safi 1984, Swern 1979, Park et al 2007.) In opinion of some authors first of all the more favourable physiological determination of the sheep milk fat comparing to the cow milk can be explained by the higher ratio of unsaturated and C4:0-12:0 fatty acids (Fenyvessy, Csanádi 1999, Haenlein 2001). Milk and the most of milk products have another special nutritional advantage because they contain n-6 and n-3 fatty acids with optimal ratio (3:1). The feeding determines the fatty acid composition of milk essentially. Authors agree that the pasturage increased the ratio of unsaturated fatty acids included CLA, but the summing up of changes in n6/n3 ratio is unambiguous not so far (Csanádi et al 2007, Boiuattour et al 2007, Lourenço et al 2007, Tsiplakou et al 2007, Sanz Sampelayo et al 2007, Cabiddu et al, 2006, Atti et al 2006).

Our objective was to explore the fatty acid composition of milk from milking Tsigai sheep.

2. MATHERIAL AND METHODS

The fatty acid composition of milk from milking Tsigai sheep was determined from individual milk samples (from 8 ewes) and bulk milk samples in a whole (165 day) lactation. The forage of the flock was based on the grazing and was characteristically

extensive type. We analysed separated milk fat samples from daily milk samples (morning + evening milking) were stored in -25°C until the analysis.

Preparation: the samples were destroyed in hot water bath with concentrated hydrochloric acid and mixed with ethanol. Afterwards the lipids extracted by ether and petrol ether (< 60°C). After combining the organic phases the solvent was removed by means of a rotating vacuum evaporator.

Hydrolysis and esterification: The evaporated samples were boiled with 0.5M methanol sodium hydroxide solution (appr. 5 minutes) and further the boiling was continued for 3 minutes with 14% methanol boron-trifluoride solution. We boiled for another 1 minute adding dried hexane and after cooling down mixed it with salted water solution. After separation of the phases we took 0.5 – 2 µl sample from the organic phase and injected it into Chrompack CP 9000 gas chromatograph.

3. RESULTS

The Tsigai's milk fat contains more saturated fatty acids than unsaturated ones as known from the references and the difference was 18.27%. We demonstrate our findings in *Fig. 1.*

The ratio of the unsaturated fatty acids (UFA) was 40.81%, and the polyunsaturated fatty acids (PUFA) was 3.82% in all fatty acids. The amount of C18:1n9c (29.98%) was the highest in all FA and it was higher about 4.0% than in fat of cow's milk.

Tsigai's milk fat also contains other PUFA as C20:2n 0.46%, C20:3n3 0.12%, C20:4n6 0.15%, and C22:2n 0.15%.

Figure 1. Different nutritional fatty acid groups in Tsigai sheep milk fat

The ratio of SFA/UFA and the amount of PUFA confirm that the sheep milk has advantages in the human nutrition.

Table 1. contains the statistical data of the bulk milk samples during the investigated lactation period.

Table 1. The nutritional Fatty Acid groups in the lactation (n=6)

FA groups	Mean	SD	SD%	Max	Min
UFA	40.81	4.91	12.03	45.26	33.74
SFA	59.18	4.88	8.24	66.16	54.69
MUFA	36.99	4.81	13.01	41.34	29.97
PUFA	3.82	0.14	3.55	4.00	3.66

The changes in the ratio of the different FA groups was smallest in PUFA groups (0.36%), while in the case of other groups were similar 11.37-11.52% but the SD% of SFA was only 8.24 contrary to the highest SD% of MUFA (13.01). The ratio of UFA was higher than the SFA's ratio was lower in samples. The highest value of UFA (45.21%) was founded in May contrary to the smallest 33.74% in September what was related to feeding.

Data showed in the Table 2. confirm that the fatty acid composition of Tsiagi's milk fat stands very close to the Hypothetical Ideal Fatty Acid composition.

The ratio of SFA, UFA and oleic acid meet the requirements of HIF and the ratio of short chain fatty acids stand very close to it. It should be noted that the milk fat contains essential fatty acids as Linoleic and Linolenic acid but the ratio of this fatty acids, mainly Linoleic acid don't reach the requirements, but the newest researches proved that the optimal n-6/n-3 ratio is lower than showed in the *table 2.*

Table 2. Comparison of the Tsigai sheep milk fat to Hypothetical Ideal Fatty acid composition (HIF)

Fatty acids	HIF %	Tsigai%
Saturated fatty acids	53-62	59.08
Short and medium chain fatty acids in total saturated FA (C4-C12)*	*10-12*	9.23
Unsaturated fatty acids	38-47	40.81
Oleic acid (C18:1n9c)	*28-32*	29.98
Linoleic acid (C18:2n6c)	*7-12*	2.15
Linolenic acid (C18:3n3)	*0.5-1.0*	0.75

So Tsigai's milk fat suit to requirements of HIF (as the milk fat from different species) except that it contains about 5.0% less essential fatty acids mainly Linoleic acid.

Nowadays, the usual diet in industrial countries contains much less n-3 fatty acids than the diet of a century ago. The diet from a century ago had much less n-3 than the diet of early hunter-gatherers (Simopoulos 2001). We can also look at the ratio of n-3 to n-6 in comparisons of their diets. These changes have been accompanied by increased rates of many diseases – the so-called diseases of civilization – that involve inflammatory processes. There is now very strong evidence (National Institute of Health 2005.) that several of these diseases are ameliorated by increasing dietary n-3 fatty acids, and good evidence for many others. There is also more preliminary evidence showing that dietary n-3 can ease symptoms in several psychiatric disorders (De Caterina, Basta 2006).

Therefore it is very important to investigate the amount and the ratio of n-6 and n-3 fatty acids in foodstuffs and its raw materials. We show the evaluation of Tsigai's milk fat related n-6/n-3 ratio in *Fig. 2.*

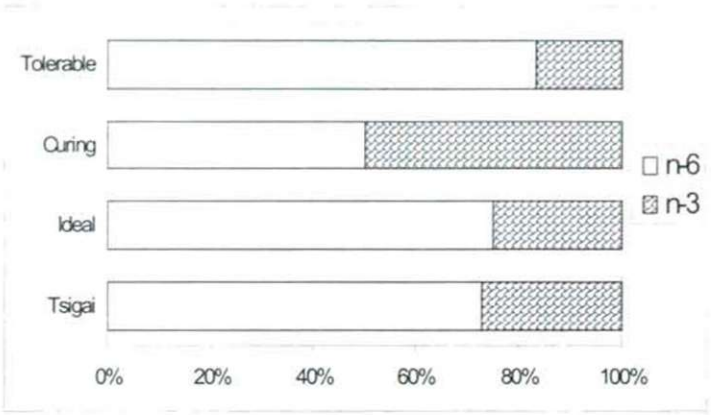

Fig 2. The place of Tsigai sheep milk fat related the ω-6/ω-n3 fatty acid ratio in the diet

Tsigai's milk fat contains n-6 and n-3 fatty acids as we mentioned at the Table 2. However the n-6/n-3 ratio in Tsigai's milk fat is optimal in the point of view of the human nutrition but the consuming of milk products per se is not enough for the supplying of daily necessity. N-3 fatty acid presented in Tsigai's milk fat is about 80% of α-Linolenic acid has the most beneficial properties in the viewpoint of the nutrition.

4. CONCLUSION

The fatty acid composition of Tsigai milk basically not vary from the other data published in the literature (published mainly in the last decade) but it has some beneficial difference.

Tsigai milk fat stands very close to the hypothetical ideal fatty acid composition as cow milk fat as well. We can state that Tsigai's milk fat contains the investigated n-6/n-3 fatty acids in optimal (healthy) ratio (2.68).

The SFA/UFA ratio also optimal in Tsigai sheep milk fat as in the goat and cow milk, but the amount of unsaturated fatty acid is lower a bit.

The oleic acid ratio *(C18:1n9c)* is noticeably higher in Tsigai sheep milk than in milk from other sheep genotypes and from cow milk.

Based on the references seems that the feeding oilseeds or vegetable oils and the pasturage has no same beneficial effect on the increasing of unsaturated oils and the n6/n3 ratio. But the decreasing of atherogenicity index of milk is an unequivocal fact.

The explored differences confirm that sheep milk (milk fat) has more beneficial nutritional aspects compared to cow milk and mainly to other fat from any food (e.g. meat or sunflower oil per se). The advantage of the FA composition of sheep milk can be reach for customers only if the consumption of the sheep milk products would be advanced also in Hungary.

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COST OPTIMIZING OF AUTOCLAVING IN EXCEL ENVIRONMENT

Z. Fabulya
University of Szeged, Faculty of Engineering

ABSTRACT

The heat treatment is the most significant regarding the energy demands of an enterprise. A heat treating cycle can be divided into three phases: heating up (with steam), holding (with steam), chilling (with water). When operating more autoclave simultaneously certain phases of the process can overlap thus the steam and water demand can develop with big fluctuation. Hence it is practical to coordinate the operation. To create the decision support system in Microsoft Excel environment, the database needed for the model has to be developed, a user friendly interface and the Visual Basic for Application software providing the timing and simulation has to be created.

1. INTRODUCTION

There are many food industry enterprises in Hungary requiring heat treating of cans, which will be subject to stiffer competition than at present due to joining the European Union. It is crucial for these enterprises to produce good quality products while optimizing the costs. One of the factors determining the quality of the cans and primarily the meat cans is the heat treatment; the process, which is the most significant, regarding the energy demands of an enterprise, so its economic aspects cannot be disregarded.

Enterprises using intermittent-duty autoclave groups for heat treating energy demand can develop with big fluctuations, which raise the costs and worsen the quality of the product. Hence, coordinating and timing the simultaneous operations is necessary.
Many publications have appeared on this subject studiing modelling of heat treating [1-6], but non of them have studied with autoclave groups.

Our purpose is to choose from the timings providing smooth water consumption where the steam demand results in lowest cost. To create the decision support system in Microsoft Excel environment, we have to develop the database needed for the model and we have to create a user-friendly interface and the Visual Basic for Application software providing the timing and the simulation.

2. MATERIALS AND METHODS

Energy modelling

We need the data to write down the two opposite sides, the demand and the capacity for the modelling. First we examine our system from the viewpoint of energy demand.

Energy demand data of the heat treatment

A heat treating cycle can be divided into three phases: heating up, holding, chilling. Steam is used typically to achieve the necessary temperature and water is used for chilling. Fig.1 shows the momentary run of steam and chilling water requirements as a function of time when heat treating a product.

Demand of resources develop in the beginning of the heat up and in the chilling phases with maximum intensity while there is virtually no steam consumption during the heat holding since only the heat loss has to be compensated.

There are different regulations on temperatures and time of heat holding for each product so the duration of the heat treatment depends on the product. Still the character of the energy demands in function of time is the same as can be seen on fig.2. This sameness does not only exist in case of different products but also in the case of steam and water utilization.

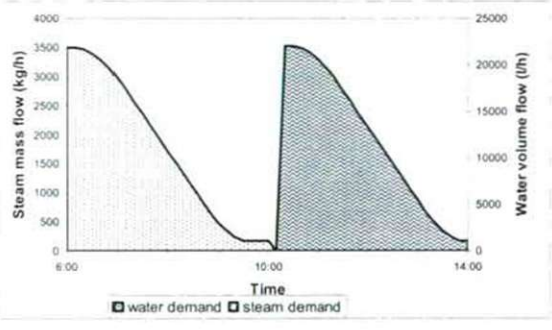

Figure 1 - Development of steam and water demand during heat treatment of a product

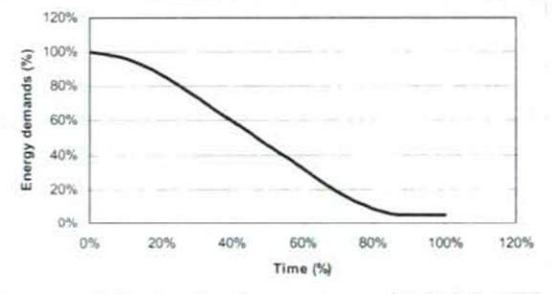

Figure 2 - Nature of energy demands in function of time in case of a product

The time in percent unit on the horizontal axis should be interpreted as the run time of the heat. The entire heat treating phase is 100 percent. The unit of the vertical axis can be explained likewise. The maximum energy demand during heat treatment is 100 percent. This characteristic curve ensures the base of computerized energy modelling of the heat

treatment with autoclave groups. If we know the duration of the heating and the heat holding, and we also know the initial i.e. the maximum energy demands in the case of every product, then by transposing the characteristic curve we have the supply side data to model the heat treating of the products.

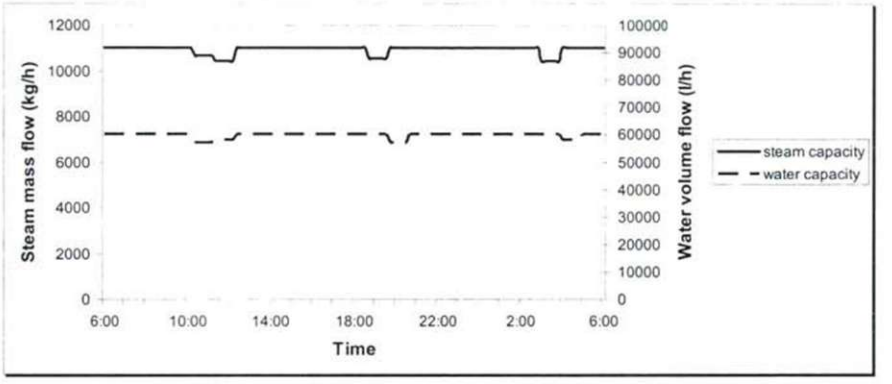

Figure 3 - Development of steam and water capacity

Modelling heating steam and chilling water capacity

The data of the capacity that can be provided for the heat treating plant of the company can be acquired by measurements. A universal characteristic curve suitable for all enterprises cannot be defined. These data cannot be accounted constant in time because of many reasons. On the one hand there can be divergence depending on the season in an enterprise too. On the other hand there can be periodical capacity variations in a day. Therefore it is practical to collect data for several days in different seasons and then recognise the regularities in the interest of modelling. For example we can get similar curves (as can be seen in fig.3) about capacity data that can be presented to the heat treating plant.

Excel and Visual Basic for Application

Excel spreadsheet provides an excellent customizable possibility to store the data of the model in a structured form. A user friendly interface can be created with custom menus and forms to manage the data. The pages containing the partial results of the calculations can be hidden from the user and the effect of the change of the model parameters modified by controls on the forms can be shown on diagrams. Menu and toolbar controlled functions and methods can be created.

3. RESULTS

Realization of timing

We made a spreadsheet to model the heat treatment energy and the timing. The spreadsheet stores:

- the data of the energy demand characteristic curve,
- the data of the product for the timing:
  - *product identifier*
  - name
  - heating time
  - heat holding time
  - chilling time
  - maximum steam mass flow demand
  - maximum water volume flow demand
  - maximum waiting time
- the data of the products to be heat treated on the current day (tomorrow)
  - *number*
  - product identifier
  - earliest time to begin heat treatment
  - wait time of the beginning of heat treatment
  - yet can be scheduled (yes/no)
- a calculating table to define the development of the sum of the steam and water demand of the products to be heat treated on the current day and respectively to sum the capacity exceeded by these
- Visual Basic methods for timing
- a diagram of steam and water consumption (fig.4)
- a customized menu to control the execution of the methods
- forms for servicing data (fig.5), for manual and automatic timing

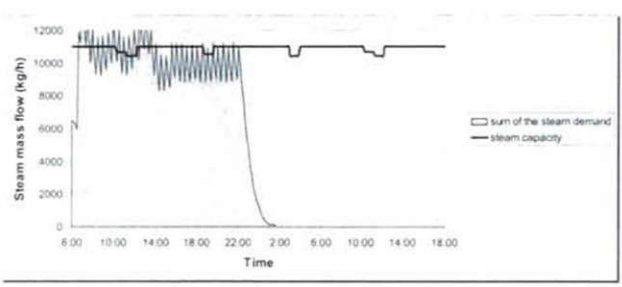

Figure 4 - Development of daily steam consumption

The menu supporting the timing tasks appear instead of the conventional Excel menu when the spreadsheet is opened. The spreadsheet contains the steam and water consumption diagram (fig.4) and the data stored in the spreadsheet the day before.

The event control programming technique of Visual Basic for Application ensures that when an event (opening a sheet, clicking a menu or command button) occurs a programme item or method is executed.

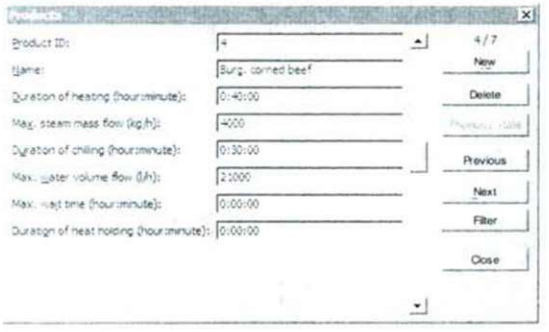

Figure 5 - Form of product data servicing

The menu structure of the programme

- File
  - New timing
  - Open
  - Save
  - Save as
  - Print preview
  - Print
  - Exit
- Data
  - Product general data
  - Products to be heat treated
- Timing
  - Manual
  - Automatic
- Help
  - How to use
  - About

When executing the "New timing" command, the programme deletes the stored product list and brings over the energy demands stretching over to the next day to give the base of the new daily data.

So the programme does not only calculate and stores the data in the period of 6:00 to 6:00 in 10 minutes detail but from 6:00 to 18:00. Thus it ensures the possibility of run in three shifts (as can be seen on fig.4).

Printing prints the product list in the order of timing.

The wait time of a product on the product list to be treated can be paced with an arrow with 10 minute steps on a form when manual setting is used. The impact of the pacing on the development of the steam and water consumption can be followed graphically on the diagrams.

The record pacer ensures the movement in the product list and the effects of pacing refreshes the index number of water and steam consumption for timing comparison.

The principles of automatic timing

When modelling the energy data, the summary of momentary energy demands of an all-day (usually the next day) is available in 10 minutes resolution. It is not worthy to work with higher resolution because the arrival of the produced cans to the heat treating plant can be counted with this inaccuracy. The limit of the timing resulting from the food safety is the maximum waiting time to begin the heat treatment. All timing – not exceeding the maximum waiting time – is optimal where the energy demand does not exceed the limit resulting from the steam and water capacity during the day, if there is a timing at all. There are two index numbers calculated in every case which can be used to compare the timings. These can be defined by the simple addition of the steam and water capacity overrun. Thus the two timings can be compared. Comparing a newer timing to an earlier one is questionable when the value of one of the indexes has decreased while the other one have increased. To give an answer in such cases the two indexes with different units should be formed to one data. This would be possible if the surplus demand of resources over the capacities could be expressed in monetary value so they could be totalled. In the case of steam utilisation this can be done if the enterprise can supply its shortage from an external steam provider but this is not viable in the case of water utilisation. If the water demand is over the capacity, the adequate speed of chilling cannot be guarantied, thus the product is exposed to more heat strain which worsens the quality of the product. So the optimum criterion of the product's quality is the smooth water consumption.

Our purpose is to choose from the timings providing smooth water consumption where the steam demand results in lowest cost so the best available product quality can be guarantied.

For the sake of completeness it should be noted that this is the simplest manageable model and as such there are several factors that are not taken into account. Our model does not calculate on the effects which come forward when the demands over the capacities cannot be covered even in case of the best timing. In this case the duration of the heat treating phases increase which is disregarded by our simple model.

The software technology based on generic dual layer network model developed to map process models on computers provides the adequate background to plan this economic process based on simulation and to realize the timing.

4. DISCUSSIONS AND CONCLUSIONS

When operating more autoclave simultaneously certain phases of the process can overlap thus the steam and water demand can develop with big fluctuation. The availability of these resources is limited or they are accessible by extra costs. Hence it is practical to coordinate the operation of the different autoclaves in the interest of thrift.

We have developed a decision support system in Microsoft Excel environment and the database needed for the model. We have also created a user friendly interface and the Visual Basic for Application software providing the timing and simulation.

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INVESTIGATION OF THE RELATION BETWEEN THE COLORANT CONTENT AND THE COLOUR CHARACTERISTICS OF THE EDIBLE OIL BASED EXTRACTS OF THE PAPRIKA GRIST

M. Fekete, G. Márton, E. Iványi
University of Szeged, Faculty of Engineering

ABSTRACT

During our work we performed the color measurements of the oily extracts from the Hungarian paprika grist. We defined a color index from the CIELab color coordinates, by means of which the rank in the redness sequence of the oily colorant extract can be evaluated. We established that there was a tight linear relation between the colorant content of the grist expressed in ASTA value and the color index of the oily extract. In case of the oily extracts the color index calculated from the data of the color measurement is adaptable to evaluate the coloring capability and via this it is appropriate for the color classification of the paprika grist.

1. INTRODUCTION

The color belongs to the basic physical properties of the paprika grist, which is one of the essential quality criterions and can be defined by the sense perception of the consumers.
Before the appearance and spreading of the photometry the color of the paprika was judged visually only comparing with the fixed specimens. Later and for the time being in the qualification besides the visual judgment the colorant content is measured too. This value is a number, which is proportional to the absorbance rate measured on a given wavelength (460 nm) of the solution derived from the total colorant content of grist by means of extraction with an organic solvent (acetone). This number is expressed in units of "g colorant / kg dry material" or in ASTA value [1]
Since the wide-spreading of the colorimeters the measurement of the grist's color and its expression in exact CIELab color coordinates are solved. However despite of this it was failed to find a classification method based on the color coordinates which would be in accordance with the ASTA value measured by photometry. [2], [3], [4].
The colorants of the paprika are soluble in fat and in the households the grist of paprika is used for coloring the meals containing edible fats. From this point of view the real value of the paprika grist is the coloring capability defined by the color of pigments solved in fats.
The aims of our study were the followings:

- To investigate the relation between the CIELab color coordinates of the edible oil based extracts and the colorants' content of the grist from different sorts of the Hungarian paprika;
- To search color classification possibilities for the edible oil based pigment extracts of paprika on the base of color coordinates;
- To establish the mathematical relation between the color index of the oil based pigment extracts and the colorant content of the grist.

2. MATERIALS AND METHODS

2.1. Materials

We used for our investigations 47 different paprika grist having colorant contents between the 48 – 225 ASTA values. The paprika were originated from the crop 2006 and harvested partially in the Szeged district and furthermore in Kalocsa district, Békés county and Zala county. The production of the grist was made in the Szeged Paprika Co and in three smaller mills while in case of 8 samples the domestic method was applied. To produce the oily extracts of the grist the refined sun seed edible oil of Floriol brand (Bunge Zrt, Martfű) was used.

2.2. Methods

2.2.1. Color measurement

For the preparation of the oily extracts 2 grams of grist was weighed with accuracy of 0.001 g and afterwards 50 g of Floriol sun seed oil was added. The mixture was heated up to the temperature of 70°C and with constant propagation kept on this temperature for 10 minutes. After this the mixture was cooled down to the room temperature and was stored in dark place for 24 hours in order to sedimentate. For the measurement of the color the HunterLab MiniScan XE Plus type colorimeter working on the spectrophotometry principle, an additional attachment capable for the color measurements of liquids and a glass graduated jar were used. To ensure the constant level of the liquid a black ring being deposited in the jar and having 1 cm height was applied. After the sedimentation the oily paprika colorant extract was filled into the jar up to the height of the ring and a white ceramic coated disc was put on the top of the ring as the background. By this way the measurement of the CIEL*a*b* color coordinates in trans-reflex mode was performed applying this white background.

2.2.2. Determination of the colouring matter content

The colouring matter content of paprika grist was determined in acetone extracts by photometry at he wavelength of 460 nm according to the ASTA international standard method. Values were expressed in ASTA unit. [5]

3. RESULTS AND DISCUSSION

3.1. Color examination of the oily extracts of the grist having different colorant contents

In this part we investigated if there was any functional dependence between the colorant content of the paprika grist expressed in ASTA units and the color coordinates of the oily extracts. We prepared the extracts from the every grist, having the same paprika/oil ratio; namely in concentration of 2 grams paprika/50 grams oil to compare the colors of the different paprika grist solved in oil. We used for our investigations the L*a*b* color coordinates of the 47 paprika grist having known colorant contents. The color coordinates are illustrated in dependence on the ASTA values of the grist on the Fig. 1.a-c.

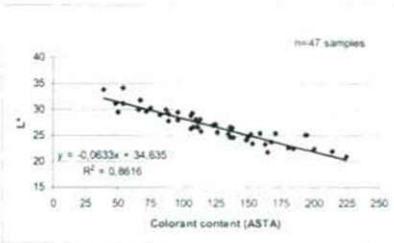

Fig. 1a

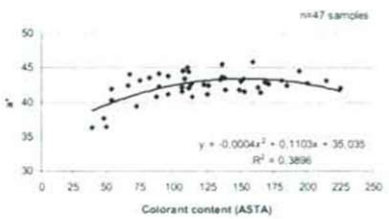

Fig. 1b

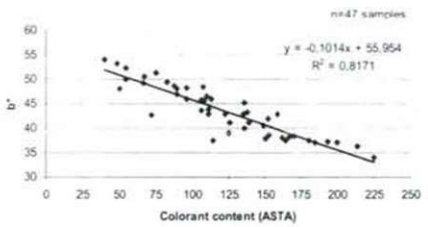

Fig.1c

Fig.1a-c: The variation of the color coordinates of the oily paprika extracts in case of the paprika having different ASTA values

The figures 1.a-c and the correlation coefficients of the adapted functions prove, that the color coordinates of the extracts have medium (L*,b*) or weak (a*) relation to the ASTA values of the grist.

3.2. The color index of the oily extracts of the paprika grist

In the food industry it is the experimental fact in the visual judgment practice, that the same quantities of grist in the same quantity of fats show wide variety of colors beginning from the orange through the brownish-red tone up to the bright red or dark ones. In order to realize the classification by color it would be reasonable to form the color index from the measured CIELab coordinates.

From the measured CIELab coordinates we created a number to establish a sequence of the redness of the oily colorant extracts and we named it as "the color index" and labeled as "CI". Creating the color index we took into consideration the meaning of the "L*a*b*" color coordinates. The increasing of the color index should reflect the higher ranks in the redness sequence of the samples. According to this the color index is directly proportional to the red-yellow coordinate ratio (a*/b*), directly proportional to the coordinate (a*), expressing the rate of redness and inversely proportional to the brightness coefficient (L*). Mathematically the color index can be calculated on the basis of the following formula:

$$\mathbf{CI} = \mathbf{100}\frac{\mathbf{a}^*}{\mathbf{b}^*}\cdot\frac{\mathbf{a}^*}{\mathbf{L}^*}$$

where:

CI: the color index;

a*, b*, L*: the measured color coordinates of the oily extracts

100: multiplying coefficient, serving to elongate the band of the color index.

The redness sequence created on the basis of the increasing of color index values and the color ranking formed by the visual judgment of the oily paprika extracts are in good coincidence in case of the grist examined by us.

3.3. The examination of the relation between the color index of the oily colorant extracts and the colorant content of the grist

To display the relation we illustrate the color indexes of the oily extracts in dependence on the colorant content of the grist expressed in ASTA units (Fig.2).

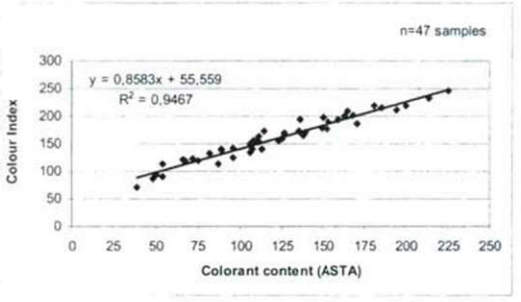

Fig. 2 – The color index variations of the oily paprika extracts in dependence on the ASTA values of the grist

The color index of the oily extract and the colorant content of the grist expressed in ASTA values are in tight linear proportion (R2= 0,95), i.e. by the increasing of the ASTA values the coloring capability of the grist will be increased proportionally; with other words the color index of the oily extract. Though the mathematical relation is rather tight between the ASAT value of the grist and the color index of the oily extract, but from the practical point of view to make conclusions from the ASTA values concerning the color of the oily extracts needs some kind of carefulness.

We can establish by the results of our investigation that for the classification of the paprika grist on the base of the coloring capability it is not enough to give the ASTA values of the grist but it is worthy to give the coloring capability using the color index of the oily extract, which can be measured and by means of the color coordinates „L*a*b*" and can be easily and unambiguously calculated.

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CONNECTING POINTS OF LOGISTICS, PRODUCT MANAGEMENT AND CONTROLLING AT MANUFACTURING COMPANIES

Jozsef Gal[1], *Eva Kmosko*[2]
[1]University of Szeged, Faculty of Engineering
[2]Villeroy & Boch Magyarorszag Zrt.

ABSTRACT

Logistic activities considerably changed in the last few years. The original aim of satisfying quantity needs has been followed by the logistic activity which meets the market's requirements, aims at satisfying the individual needs instead of standardized solutions, maximal the additional values, and finally, which gives a complex service. These together mean a significant challenge for this profession.

1. INTRODUCTION

The most important purpose of the companies is making the most of the profit-productive capacity of the invested capital that manifests itself in the increase of the company's value. Claims laid by owners – profit, dividend, share- set the management a serious task. We can be witnesses of continuous changes in the framework of the market economy in the fields of products and services, also in the labor-, money-, and capital markets. That is why it is not a negligible question to answer that what inner conditions our firm has, that is what kind of combination and organization structure of the product sources it has. That is what can influence the quality of answers and reactions to the changes of the outside environment. (Halászné 1998)

During reactions the relationship between the company and its outside environment is continuously changing. However, it is not the same at all whether we can get closer to or further from the market claims by our reaction. (By market claims we mean the ones of the consumers, owners, creditors, employees and suppliers.) Controlling, which provides a suitable tool for realization of the required activities, is destined for supporting this above mentioned aim. (Hargitai S. 1996, Körmendi L. – Tóth A. 1998)

By coordinating the given planning, analyzing and accounting elements, controlling can create an informatics system with the help of which the different structural parts are integrated into one single unit oriented on decision and management. It opens up new vistas to mobilize the inner forces in the interest of the strategic objects.

Each company has a different controlling system, but what they have in common is that the continuous process of planning-controlling is indispensable for their successful operation. This process explores causal relations, predicts economical consequences, so it transforms the operative analytical assessments into direct information for the management.

2. INFORMATIONAL SYSTEM OF LOGISTICS

Information systems are able to store the customers' needs, to compare them with the

available stores (with regard of material, goods and final product), to make a manufacturing plan, to decide over the additional material and product need, to follow the processes of store keeping, outfitting and packaging, to fix goods delivery and finally, to evaluate all these processes. (Forgács A. 2007)

It is impossible to collect, treat and process information without the appropriate information system. Most of the companies operate different subsystems to follow the reserve economy, marketing, and the processes of production, accounting and controlling. Logistics is exactly the field where these data have to be administrated as a system and these processes have to be made transparent and controllable because it is essential for the efficient operation.

With the help of the well-operating information systems the effort of the employees can be rationalized since the time-consuming check of different subsystem data can be eliminated.

Following the supply movement through the different subsystems makes the flow of both logistic and controlling information simple and efficient which has a direct effect on the quality of services provided for customers. The daily bookkeeping of accounting and controlling data supports the current data process, offers the opportuntiy of the quick intervention.

3. COINCIDENCE OF LOGISTICS AND CONTROLLING

One of the controlling tasks is to evaluate and support the logistic activity. For this, controlling provides logistics with tools for analysis and evaluation, and an appropriately structured flow of information from the point of view the functional approach.

Connecting points

- cost calculation and cost analysis of the logistic activity, focusing on the fields of possible intervention,
- calculations on the investment-profitability with regards to the logistic tools,
- store-controlling,
- simulations, calculations,
- following the value production in the field of logistics, process analysis of the logistic chain of purchase-production-product treatment- satisfying customers' claims. (Figure 1)

'The major aim of logistic controlling as a 'service' is to support the objects and strategies of the given company with its collected feedback, to process and apply methods for checking their parameters, and cooperating this way, to support the optimal organization, control and the necessary financial background of the logistic processes.' (Knoll I. 2003)

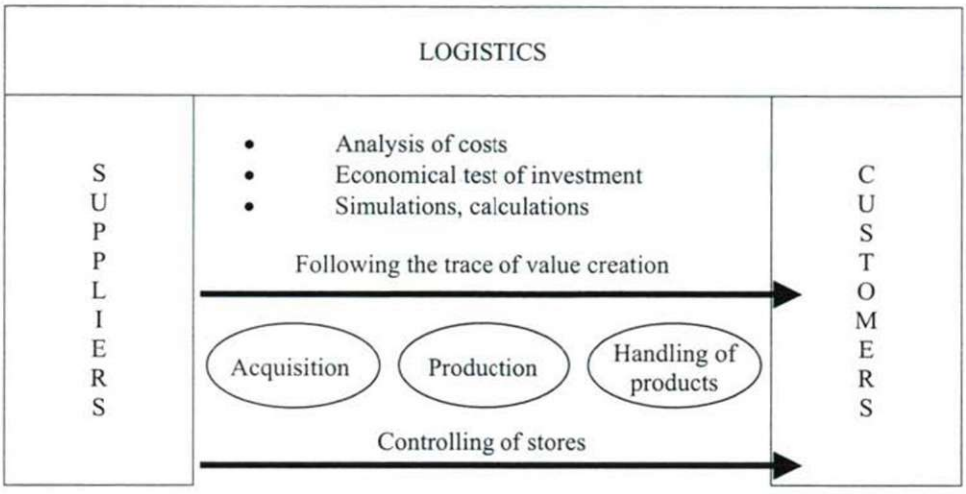

Figure 1: Conrolling-logistics model (Gal-Kmosko)

Logistic controlling within the company organization can be operated in the following ways

a) given departments or parts of departments within the controlling organization perform this duty,
b) given departments or part of departments within the logistic organization perform this duty,
c) departments or part of departments within both of the logistic and controlling organizations perform this duty together.

When we choose from these three alternatives it is important to consider the size of the company, the size and complexity of the logistic activity, the size and tasks of the controlling system, the scope of responsibilities and authority within the company. Solution c) can operate when the controlling system is active in the fields of those factors which influence the effectiveness of the company, while logistics is busy in the fields of those activities which improve its own processes. This way cost calculation and analysis; calculations on the investment-profitability, store-controlling, following the value-production belong to the duties and authorities of controlling, while analysis of the chain of purchase-production-product treatment-satisfying customers' claims mean duty in the field of logistics. Close cooperation and the appropriate flow of information between the two areas provide a successful logistic controlling activity.

4. COST CALCULATION, COST ANALYSIS OF THE LOGISTIC ACTIVITY, FOCUS ON THE FIELDS OF INTERVENTION

The value increasing conception is specified in strategic objects, in the forms of long-, and short-range plans, and at the same time the contribution of each responsibility areas to the realization of the company aims is put down. The controlling system arranges for the

control – oriented on productiveness and liquidity – according to the plans, for the takeover of the controlling-philosophy. In this respect controlling undertakes an operative duty in the takeover of the conception and in the interest of which it makes the tools of reporting and planning available to the whole company.

An example for the planning process:

In the first stage of operative planning is a marketing plan, which focuses on the market needs, is made that estimates the salable quantities with regards to each product group. The quantity plan is followed by a price plan with the help of which the natural data are formed into values or return from sales. For further planning it is essential to divide the quantity for sale into self-made store and goods from outside suppliers.

Considering the store available at the beginning of the planning period both the quantity to be purchased and the quantity to be produced by the company can be calculated which is put down in the purchase and production plan.

At this point it is indispensable to examine the capacity plans both in short and long-range and to compare them with the quantity plan. It may be necessary to implement enlarging investments in addition to the supplement of the given capacities. We can apply for it from the investment frame determined in the strategy plan by presenting the calculations on profitability.

The investment plan is built up on the basis of the winning projects which influence the liquidity-, and cost plans. The given tools and the planned investments determine the value decrease plan of each responsibility area. This plan is part of the fixed expenses. Value decreasing description of logistic buildings, machines, equipments and vehicles should be indicated under this category of expenditure. (Figure 2)

A human labor force-plan is needed in addition to the establishment of tool conditions, which includes the requirements on staff numbers and other professional factors.

Personal expenditure plan shows the wages, fringe benefits, work clothes and other personal payments for the workers who provide the logistic operation.

Different services and other expenses are settled after a consultation with those who are responsible for costs, making use of the characteristic features of the responsibility area. The following expenses are accounted here: invoices of outside carriers and different suppliers, IT-developments and costs of telecommunications.

It is practical to sort the expenditures on material into both the direct and indirect cost categories and to plan the direct items flexibly. By direct expenditure on material I mean the material consumption in connection with packaging and fitting which is product-dependent. At this cost category the additional-value creation has to be examined and not the sheer cost. Standard costs calculated on the given product group can create a perfect ground to measure performance, since comparing the actual costs with the given standard cost can provide the controller with a flexible plan-fact analyzing tool. Standard cost calculation can be expanded to the other expenditure categories, and this way we can standardize the cost of the whole working process.

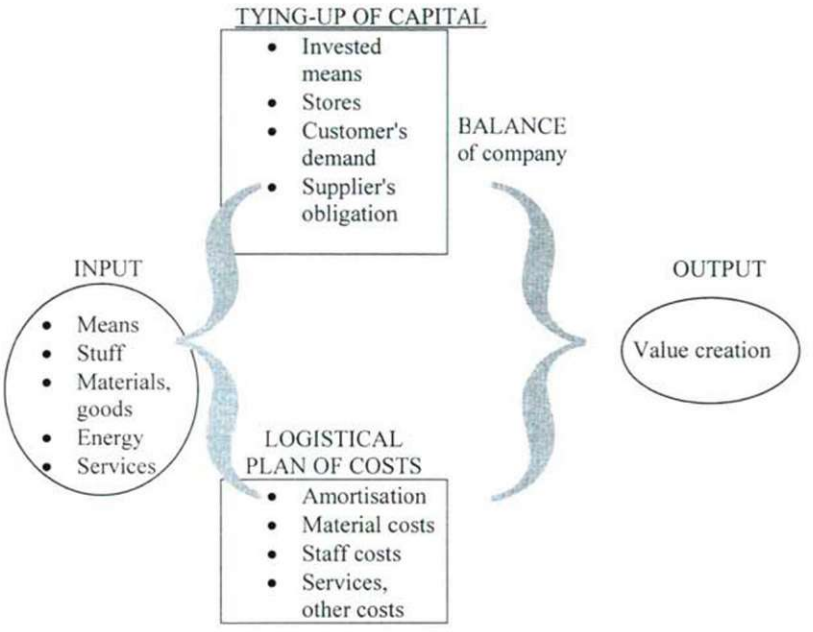

Figure 2: Procedure of value creation of logistics (Gal-Kmosko)

The expenditure plan made this way can serve as a base to measure the effectiveness of the logistic processes, and by evaluating the facts, it can help indicate the areas to be corrected and draw up a measure plan.

5. CALCULATIONS ON THE INVESTMENT-PROFITABILITY WITHREGARDS TO THE LOGISTIC TOOLS

Reduced sources require their well thought-out, efficient and clear appropriation. So the investment projects –as the potential sources of value creation- have to be „competed" for the money available without restraint.

Objects, categorization, costs and the potential results of the investment projects can be compared by the presentation and analysis of future cash flows. It is advisable to list the alternative solutions, to work out their financial consequences, to analyze and evaluate them when a decision on investment has to be reached. We should not preclude the alternatives of leasing and tenure.

Typical logistic investments

- building, enlarging stock-yard, building up storage units
- obtaining tools for moving materials and goods
- purchase IT-equipments, installment of software

Project developments have to be followed, as exceeding the permitted amount, or the actual time of putting the things into operation have a significant effect on profitability. The expected results have to be examined continuously, at least every year.

6. STORE CONTROLLING

Optimal of reserve economy has more and more important role in the life of companies since decrease of proportion of the locked-up capital is regarded as a factor of effectiveness. For this, controlling operates a system of analysis and evaluation with the help of which the following factors can be measured regularly (e.g. monthly): level and composition of the company reserves, the risk level on the basis of consumption rate, stock circulation, marketing status.

During the operative planning (a period of a year) the reserve economy plan – volume and the total value of purchase, production, consumption and sale- means a starting point for logistics. The excess of the monthly reserve levels fixed in the operative plan, divergence from the planned reserve descriptions, increase in the reserve risk, or decrease in the market sale, and finally, increase in the frozen stocks are all examined by controlling. After this examination logistics and controlling make the measure plans together, cooperating with each other, then the effects of the measures taken are examined, analyzed by controlling. The suitable report is sent to the logistics, and on the bases of the feedback it can be discussed if it is necessary to intervene in the given area.

7. CONCLUSION

Calculations are on the investment-profitability with regards to the logistic tools. The proactive activity of controlling is realized by simulations and calculations in connection with future. The question „Shall I produce it myself or make it produced by somebody else?" has an important role in the field of logistics, that is whether the company itself produce the products, services; or its capacity, its human and other resources, their cost and other factors support outside purchase, or outsourcing of the given activity.

Logistic terms of this question can be the followings:

- self-made product or purchase from other source;
- activity of assembling, packaging;
- activity of freight arrangements;
- transportation;
- administration.

Following the value production in the field of logistics you can see process analysis of the logistic chain of purchase-production-product treatment-satisfying customers' claims.

Production and purchase plan induced by the customer's claim can be made by programming the practical experiences, by using the collected, systematic facts; or by working up perfectly new information.

I have mentioned that it is important to follow the movements of reserves. The accurate and high-quality work of suppliers gives the basis of the proper activity.

Essentially important factors are: order, accept and the suitable treatment of inputs; their structured, accurate storage and the conveyance of materials. Optimal of these processes is the fundamental task of the logistic process organization, and controlling can help it with cost calculating tools. Areas of optimal are decrease of time between order and transportation, minimal of the way and number of the conveyance of goods, decrease its speed, optimal of transit time.

Customers' claims and their satisfaction

Nowadays, the controlling activity focused on customers and their claims are given a key-role. Although, the marketing and financial controlling are focusing on the real return from sales and the financial execution for goods and services, we should not leave our own performance out of consideration. From the point of view of logistics we have to measure and evaluate transportation, its accuracy (time and content), its quality and the customers' satisfaction. The evaluating system can include post-correction of a specific customer claim, evaluation of a not 100 per cent performance.

It is certain that nowadays one of the tokens of the economical and financial success is the high-level controlling and logistic system.

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THE FIRST ATTEMPT OF THE SLOVAK REPUBLIC FOR REGIONALIZATION, OR THE ADMINISTRATIVE REFORM OF 1996

László Gulyás
University of Szeged, Faculty of Engineering

1. INTRODUCTION

Communism in Czechoslovakia came to an end with the 'velvet revolution' of 1989 and the communist party-dominated regime collapsed within days, a situation, which meant that the changing of the political system could immediately take momentum. In the meantime the relationship between the Czech and the Slovak inhabitants of the country was worsening and this situation eventually led to the disintegration of the state itself; on January 1, 1993 the states of the Czech and the Slovak Republics came into being. Our research is aimed at investigating the first administrative reform of the Slovak Republic, ratified on July 24, 1996 (221/1996), inclusive of the phenomena that had preceded it. During our research a special emphasis was laid on introducing the issue of how the Hungarian minorities living in Slovakia were affected and discriminated by the reform.

2. THE CZECHOSLOVAK HERITAGE 1968-1992

In the communist era state and local governments did not exist separately; the communist party exercised power through the institution of the National Front. It was also the National Front that nominated representatives who were then eligible for being elected and, following the formal elections they were the ones who eventually had to carry out the orders of the communist party.

Map 1. Areas and districts in Slovakia 1968-1991

Source: Petrőcz, 1998. p.112.

From 1969-1990 three administrative levels existed in Slovakia. (See Map 1) The top level was the area level and there were four of those in the country. The middle level was the district level and there were 38 of those. On bottom level there were the 2700 settlements.

The communist party set up the so-called National Council in each area, each district and settlement and exercised power through them. The system of national councils ceased to exist in 1990 under the proposition of the Czech and Slovak National Councils. Under the new laws (369/1990 and 472/1990) the administrative system of Slovakia was fully transformed. (Petrőcz 1998)

Law 369/1990 eliminated the national committees and separated state- and local-level administration. State administrative tasks were delegated to district level, while the individual settlements were legally administered by local governments. This is a dual model, in which state adminstrative tasks are performed by districts, while the settlements acquire local administrative roles. (Józsa, 2004)

Law 472/1990 abolished the level of districts within state administration, while it left the 38 zones intact and within each of them 2-4 smaller administrative units were organized. As a result, a total of 121 administrative zones came into being. The administrative spheres of authority were divided among regional offices, preferably in such a way that citizens could do their official business as close to their place of residence as possible. (Petőcz 1998) According to specialists it was due to these two laws that the Slovak administrative system of the era approached western European norms. (Petőcz 1998)

At the same time the question of further reforms was also raised. A parliamentary committee, commissioned by Jan Carnogursky, the Slovak prime minister from April 1991-June 1992, proposed continued administrative reforms in May 1992. According to that proposal, in the Slovak part of former Czechoslovakia 16 counties were to be established, and, within them the establishment of 77 smaller districts was proposed. Historical traditions, geographical conditions and economic as well as social needs were to be taken into consideration when reorganizing the country's administrative units. It was also decided that the administrative units were to have approximately the same number of inhabitants. In addition, the counties were to have been governed by elected local governments. (Mezei 2004)

The committee's proposal was not put to debate, because prime minister Jan Carnogursky, who emphasised the role of counties in his administrative policy, was soon to leave the political scene and he was followed by Vladimir Meciar in June 1992. (Kovac 1996) During the second Meciar government (the first Meciar governemnt ruled from June 1990-April 1991) the issue of the formation of the county system was removed from the agenda. At the same time Meciar contributed to the sharpening of the debates in relation to the afterlife of the Czechoslovak state, and as a result of his political views, the conflict between Czechs and Slovaks became the centre of home politics. This conflict remained unsolved and this situation eventually resulted in the breaking up of the Czechoslovak state. (Hamberger 1997, Gulyás 2005).

3. GENERAL CHARACTERISTICS OF THE MECIAR ERA (1992-1998)

The Slovak Republic, which became independent on January 1, 1993, was defined by the constitution of the country as a Slovak state, despite the fact that a considerable number of minorities –about 15% -lived within the country. (See Table 1). The period from 1993 to 1998 was defined by the increasingly dominant Slovak nationalism (Gulyás 2005). This political trend was most characteristically represented by the figure of Vladimir Meciar, who, during the investigated period, functioned as the country's prime minister on two occasions. Considering the dates, from June 24, 1992 - March 11, 1994 was the period of

the second Meciar government, then from March 15, 1994 – October 1, 1994 was the period of the government of Josef Moravcik, and eventually, October 1, 1994 – October 10, 1998 was the period of the third Meciar government.

As it can be concluded form the above dates, the new government led by Josef Moravcik proved to be short-lived, thus, except for a brief period of four and a half months, it was practically Vladimir Meciar who was the country's prime minister for a six-year period, from 1992 through 1998. The most characteristic feature of that period was that Meciar and his party – especially during his third term- in addition to political key positions, also dominated the media, and during this period the electronic media actually functioned as the mouthpiece of the government. Meciar also tried to control the country's economy, especially privatization processes. (Kovac, 1996, Lesko, 1998) In these attempts the democratic rights were often abused and it was also the period of several unlawful acts. The most scandalous of these was that the secret service kidnapped the son of the president, that person's, who functioned as counterbalance to Meciar in political life (August 1995). In addition the two investigators of the case were also removed from their jobs, and eventually a person, related to the crown witness was murdered, too. The European Union and the United Stated attempted at warning Meciar in a diplomatic way, but neither of these attempts brought any result of significance. Due to these chracteristics the early Meciar era can be evaluated as a negative period in the history of the young Slovak state. Slovakia's domestic politics and the country's economic development were very different from the political practices of the other three countries of the 'Visegrád Four '. As a result, in 1999 Slovakia was not considered for NATO membership during the first round of NATO enlargement. The situation was the same with EU membership, since by 1998 Slovakia was excluded from the group of candidate countries, too. (Boross 2000/a)

Table 1.
Ethnic breakdown in Slovakia, based on 1991 census figures

Nationality/ethnicity	number	%
Slovak	4,606,125	85.7%
Hungarian	578,408	10.8%
Czech	65,216	1.1%
Ruthenian-Ukrainian	38,979	0.7%
Romany	80,627	1.6%
Other	1,163	0.03
Total	5,289,608	100.00%

Source: Kovac, 1996. pp. 1312-313.

In the Meciar era serious problems emerged in the relationship between the Slovak majority and the Hungarian minority living in Slovakia. The Meciar governments radically cut the state funding of minority cultures and many people, who considered themselves Hungarian, were dismissed from their jobs in the government sector and, in addition, renewed attacks were carried out by the government against minority education. (Boros 2000/B) In addition, using the new legislation related to the use of Slovak as the only state language, the official use of Hungarian was made impossible in administration. Since this problem is very complicated, a paper of this length cannot fully explore the complexity of the language problem; instead, as it was stated in the title, those steps taken by the Meciar

government will be examined, which had a disadvantageous impact on the Hungarian population.

4. THE MECIAR GOVERNMENTS AND THE ADMINISTRATIVE REFORM

4.1. The draft of 1993

Meciar recognized those political opportunities which lay in the restructuring of the country's administrative system. He tried to change Slovakia's administrative system in order to be able to grant key positions to his own party. This attempt can very well be seen in the fact that he replaced law 472/1990 with 487/1992. (Petőcz 1998) While under law 472/1990, ratified by the Czechoslovak state, the administrative leader of any district had been elected by the mayors of the settlements of the given district, Meciar's law of 487/1992 modified it and said that the administrative leader is appointed by the leader of the area. In which the district lies. Since the leaders of the individual areas were appointed by the government itself, by modifying the former law, the government acquired the right to appoint the regional administrators in all 121 administrative districts. It is also obvious that the second Meciar government filled all these positions with its own people. Meciar also intended to use the restructuring of the administrative system as a weapon against the Hungarian minority. At the end of 1993 the second Meciar government prepared the concept of the division of the country into 7 administrative regions. (See Map 2)

Map 2. The proposal of the 2nd Meciar government for Slovakia's regional division

Source: Petőcz, 1998 page 118.

Seven regions were proposed by Meciar and there were Hungarian minorities in five of those. There was no Hungarian community of considerable size in the area of Žilina (Zsolna) and Prešov (Eperjes). The number and proportion of ethnic Hungarians is shown in Table 2.

Table 2. The number and proportion of ethnic Hungarians in the proposed regions of 1993

Name of the region	Total population number	Number of Hungarians	Proportion of Hungarians
Bratislava	588,059	30,083	5.12%
Trnava	810,538	157,919	19.48%
Nitra	893,448	196,149	21.95%
Zvolen	634,343	84,682	13.35%
Kosice	836,004	96,343	11.52%

Source: Petőcz, 1998. p. 119.

In order to interpret the table it is important to consider that according to the language law of 1990, as well as the 1994 law regulating the use of sign boards, 20% is the limit in any settlement for practicing minority rights. It means, that in a given settlement, if the number of ethnic population exceeds 20%, those who belong to the minority can use their own language in local administration and they can use bilingual sign boards within the limits of the settlement. From the table it is evident that Meciar's intention was to keep the number of ethnic Hungarians below 20% in the proposed regions, thus in four of those, except for the Nitra region, they would not have been able to exercise their rights. (Petőcz, 1998) During the second Meciar government, due to its own political instability - inner conflicts leading to resignation were common in the government party faction -, and also owing to the protest of the Hungarian minority, the draft bill of 1993 did not pass.

4.2. The administrative reform of 1996

Meciar's third government, which came into office in October 1994 (Boross, 2000/c) put the problem of administrative reform on the agenda again. This step caused the relationship between the government and the Hungarian minority change from bad to worse. Two issues need to be considered in this respect. The first is, that although the third Meciar government signed an agreement of cordiality with Hungary in March 1995, a document, which is called the Slovak-Hungarian Charter, they did not even make an attempt at keeping it; they treated the Hungarian minority with hostility. (Boross 2000/d) The 1995 law on language rights purposely discriminated against ethnic Hungarians. At the same time the Hungarian minority of Slovakia elaborated a different version of the administrative reform, which suited their interests better.(Szarka 2001) There is no opportunity to describe the Hungarian version in details within the framework of this paper, but the most significant characteristics of it will be given below

According to the resolution of the general assembly of Komarno of January 6, 1994, a unified 'Hungarian' region be established in those areas of southern Slovakia, in which the Hungarians constitute the majority. The Party of Hungarian Coalition developed the idea further and submitted the new version in the 1996 parliamentary debates of the administrative reform. At the same time the draft proposal of the Union of Towns was also being elaborated, a proposal, aimed at creating 16 counties and 78 districts within them. (Petőcz, 1998) On the other hand the third Meciar government also submitted a draft proposal, according to which Slovakia was to be divided into 8 regions and 79 districts. In the parliamentary debates the faction of the government party turned down both proposals,

the one by the Hungarian Coalition Party and by the Union of Towns as well. The president - because of the special status of Bratislava – returned the proposal to the parliament for a new debate. Following a lengthy debate the parliament eventually approved it with amendments on July 7, 1996.
Meciar intended to strengthen his own political power by establishing the 8 administrative regions in a way that he 'rewarded' those regions, in which his party had won (e.g. the Trenčin region) and 'punished' those (the Prešov and Banská Bystrica regions for example), where his party had lost.

Map 3. The regional division of Slovakia. 1996.

Jelmagyarázat: 1 – Országhatár; 2 – Kerületi határ; 3 – Járáshatár; 4 – Kerületi székhely.

Legend: country border; district border; zone border; district centre

Source: Horváth 2004. p. 428.

The next question to be examined was what changes the administrative reform held for the Hungarian minority. When drawing the region's borders the Meciar government abused the principle of ethnicity on several occasions. Two facts are of major significance in this respect. One is that the Csallóköz region, populated by Hungarians, was divided into two parts and it was shared between the Trnava and the Nitra regions. It meant that the Slovak government deliberately fragmented those areas, which were homogeneously inhabited by Hungarians. By doing so the Slovak government abused a basic international principle, according to which governments should refrain from changing the ethnic proportion of inhabitants living in multiethnic areas. On the other hand in mixed-population regions it was the Slovak towns situated above the Hungarian language border which were designated as regional centres. For example in the Banská Bystrica region it was the town of Banská Bystrica in the north that acquired the leading role, as opposed to the Hungarian towns of Rimaszombat (Rimavská Sobota) or Losonc (Lučenec) in the south. In the Trnava and Nitra regions the regional centres were also located in the far north, and it meant that the Hungarian inhabitants of the southern areas had to travel great distances to attend to their business in the offices of the regional centre.
If the administrative reform of 1996 is examined from the point of view of the individual districts - for details see research by Kálmán Petőcz (Petőcz 1998) - the conclusion can be drawn that the intention was to put the Hungarian minority in a disadvantageous position. Two facts are of special significance in this respect. One is that the area as well as the number of inhabitants is bigger in the southern districts, which are inhabited by Hungarians, than in the northern ones, populated by Slovaks. It means that when developmental funds are distributed by districts, the proportionately larger and more populous southern districts get less. The second important fact is that when designating

towns to become district centres, the towns with Slovak majority became district centres in larger numbers than the Hungarian towns. Out of a total of 15 towns with Hungarians in majority, it was only two that did become district centres.
In summary it can be stated that the Meciar administrative reform of 1996 meant a definite disadvantage for the Hunagrian minority in Slovakia, both on regional and also on district level.

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DATA SOURCES OF DECISION SUPPORT IN THREE SIGNIFICANT FOOD INDUSTRY COMPANIES

György Hampel
University of Szeged, Faculty of Engineering

1. INTRODUCTION

Managerial decision making is a complex task where the manager supervises the process by which the organization reaches its goals and mission, and he also ensures the concordance of the activities. The manager has a lot of tasks to do: he employs, directs and supervises. The manager inspires others to work, appoints the goals of the employees' activities, coordinates the different actions, ensures the conditions of work and uses all the possibilities of influence. The manager is the one who makes decisions. Sometimes he makes good and sometimes bad decisions, but always he is the one who makes decisions. Some of the most important tasks of the managers are: planning and decision making, organizing, supervising. (Berde, 2003)

Making proper decisions requires planning. Planning is a decision about the active forming of future, and it is an inevitable tool of corporate competitiveness. Besides advantages, planning has disadvantages as well, for planning — due to its nature — is burdened by uncertainties and requires a considerable investment. Uncertainty can be reduced by proper information; albeit, certain pieces of information are not available and defining the optimum information quantity necessary for planning and forecasting future information is also difficult. As far as investment is concerned, one should take care that planning costs should not exceed profit available by planning. (Hampel, 2006) "The main objective of the planning system is: to make it real that the company can work successfully in the future, achieve its objectives on a high level and manage its business effectively." (Hanyecz, 1995) Generally speaking, decision making is a process of selection, with a scope of different action (or non-action) possibilities, i.e. decision making is deciding about an option to act. The gist of decision making is "to define if it is necessary to act, and if it is, what should be done, when, and in what order". (Hanyecz, 1994) Decision is objective (i.e. reality limits and determines actions available) and subjective, for it is inseparably linked to the subject of the decision maker.

Traditional paper based information systems of companies tend to be replaced by computer aided enterprise (resource planning) systems.There are three stages in the development of computer aided information systems: (1) Electronic Data Processing aiming at the efficiency and automation of information management; (2) Management Information System, enhancing executive information supply; (3) Strategic Information System, aiming at the improvement of competitiveness and activity development.
Current groups of computer aided information systems used these days at the enterprises are: office automation systems, production scheduling systems, enterprise asset management systems, enterprise management information systems, executive information systems, workflow systems, process simulation systems, expert systems, and business intelligence systems. Some of these systems are capable of standalone operation, others may run as subsystems embedded into other systems, or they can have overlapping functions with other systems.

Any decision support system works as an element of the enterprise information systems mentioned herein, and not as an independent system. A decision support system (DSS) may cover various systems and technologies. (1) Some say that the future is for On-Line Analytical Processing, by which controlling and executives may receive immediate answers concerning the management of the company. (2) Others say that the establishment of knowledge based decision support systems should be urged. (3) Those involved in operations research primarily focus on optimization and simulation, and they consider these two as real DSS.
So DSS means multiple information systems, which are capable of supporting decision making. DSS can help executives to access, summarize and analyse data necessary for decisions. It can be based on data and models, may cover the entire enterprise, serving many executives via the network and connecting to an appropriate data warehouse in a client–server architecture, or can even be a single user system running on an executive's desktop computer. (Hampel, 2006)

In our days the Southern Great Plain is in for a historical decision. Because of the region's backwardness a direction of development takes shape which offers the possibility of competitive closing up. The enterprises, respectively their managements have to react suitably on several environmental challenges. It is of capital importance for the managers to maintain the competitiveness of the enterprise, but other factors (like economic, social and environmental consequences) have to be considered too. (Gál, 1999)

2. THE SURVEY

There are many food manufacturing companies in the Southern Great Plain that face stiffer competition after European Union accession. For these companies prompt decision-making by the management is crucial. To make good decisions it is essential to have accurate and reliable data and information.
On the one hand, data required for managerial decision making are data necessary for the management of the company at all times: these data appear in the finance, accounting and statistics documentation of the company (e.g. data about production, stocks, supplier, sales, customer, financial standing of the company, plan implementation, assets, etc.), and on the other hand managers need information at times when making specific decisions in business (e.g. information about how well the company is doing on the market or the image of the company).

In summer 2007 the managers of three bigger companies were asked in Szeged city. The companies were Pick Szeged Close Company (CCo.), Sole-MiZo CCo. and Szegedi Paprika CCo. Pick Szeged is involved in meat processing, Sole-MiZo is the biggest diary product processor in Hungary, while Szegedi Paprika is an important participant in the Hungarian paprika and canning industry. The objective was to survey the source of data and the information the managers use for managerial decision making.

In order to acquire the necessary information a questionnaire was prepared and the managers were asked to fill it in. The questionnaire contained different aspects of decision making and the possible sources of data and information, such as:
- the field of decisions: finance, production and services, marketing, trade, production factors etc.
- the subject of decisions: market-economic, technological, organizational etc.

Data and information can come from different sources, such as:

- people: shareholder (owner), manager, employee, supplier and customer;
- business environment: bank, competitor etc.;
- governmental organizations: nation-wide, regional and local organization;
- non-governmental (civil) organizations: nation-wide, regional and local organization;
- internal reporting systems: decision support system, planning, finance, accounting, controlling, supply, sales, production, quality assurance, inventory adjustment, human resource management etc.;
- statistical information sources: annual report, monthly report, periodic statement, methodology publication and analytical publication;
- research institutes: organization of the Hungarian Academy of Science, higher education, economy research institute or company research done by research institutes;
- data banks: statistical data bank, name and address register or company register;
- professional communities: newsletter, forum etc.;
- public media: television, radio, professional newspaper, non-professional newspaper and internet.

The managers were asked to classify each data source with numbers (3: most often used, 0: not used). The given numbers were then transformed during the processing of questionnaires so that they could be compared.
The managers were also asked some questions about the computer aided information system of the company:

- Are there one or more integrated information systems, or different information systems with connection between them or with no connection?
- Does the company use computer systems to do office tasks, accounting, invoicing, stock management, supplier and customer management, logistics tasks, resource planning or other important tasks?
- Is the applied system a standard (already built) system set up for the company's needs, which can be bought on the market or is it a uniquely developed system ordered by the company, or both?
- Is the information system capable of analysing the current situation and can it also present forecasts based on the supplied data?

3. THE RESULTS

As expected, the company's internal reporting system was marked as the most often used source of data for management decision making (65.36 points). The second most often used source was the people (59.80 points). Then the third information source, the public media followed far behind (33.40 points). Statistical information sources (19.60 points), data banks (18.40 points), research institutes (17.40 points) and non-governmental (civil) organizations (5.00 points) are the least used data and information sources for decision making. (See figure 1)

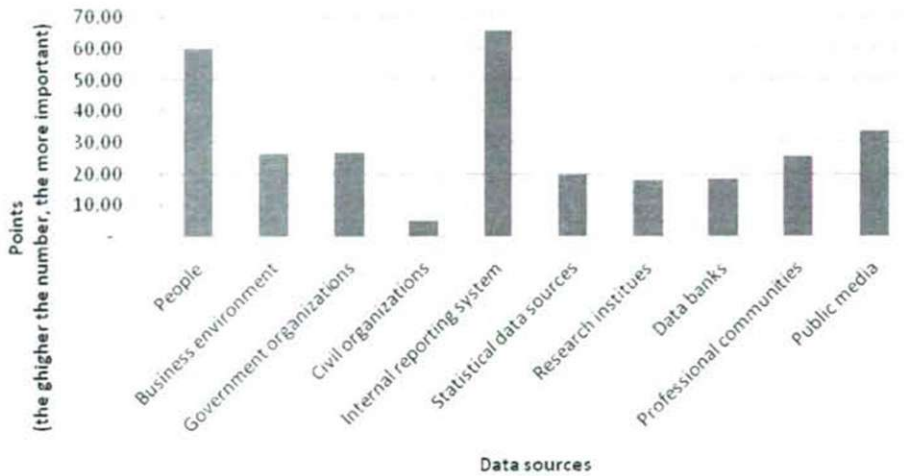

Figure 1. Data sources used by company managers (Pick, Sole-MiZo, Szegedi Paprika)

Regarding the internal reporting system, all the subcategories (decision support system 8%, planning 8%, finance and accounting 10%, controlling 9%, supply 10%, sales 9%, production 9%, quality assurance 11%, inventory adjustment 11%, human resource management 10%) were marked equally important and frequently used. (See figure 2.)

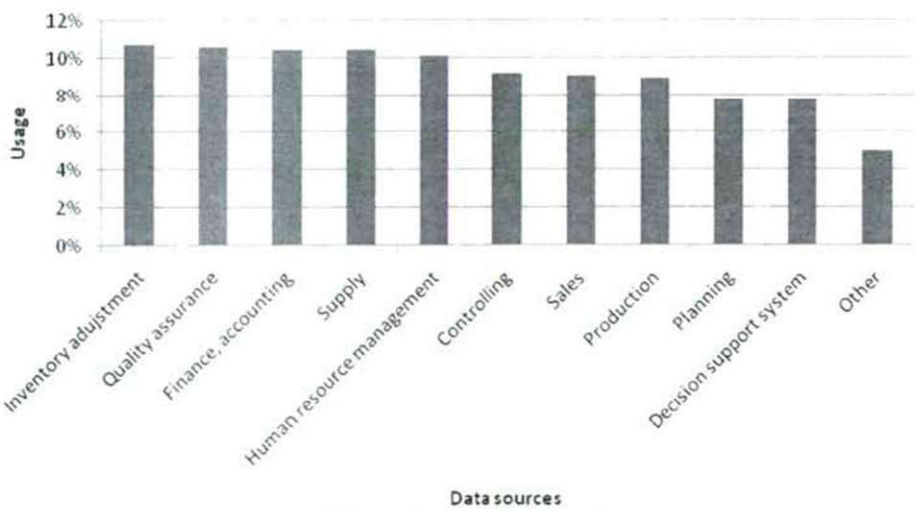

Figure 2. Internal reporting system

Among the people, managers (27%), employees (25%) are the most used data sources, owners (14%) are the least used according to the managers. (See figure 3.)

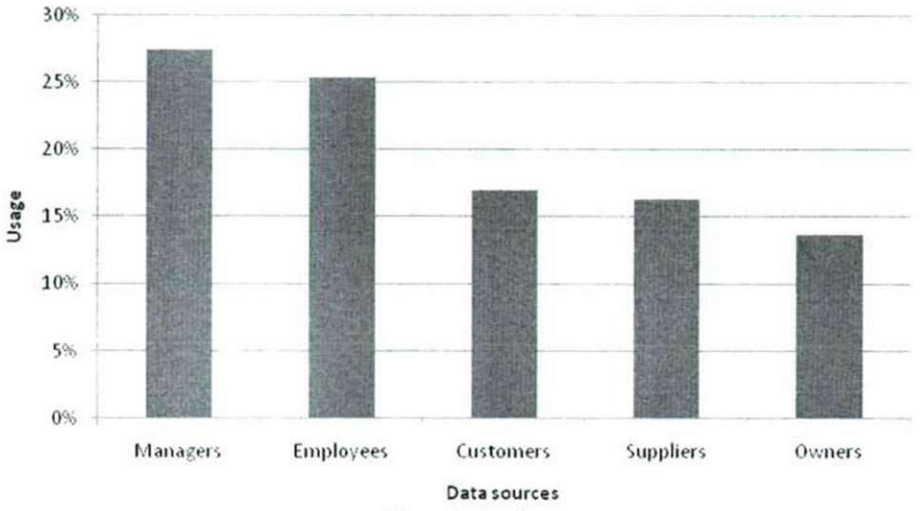

Figure 3. People

The public media also plays an important role as source for managers. (See figure 4.) As a decision source, the television (8%) and the radio (4%) are negligible, the internet (39%) and the professional newspapers (37%) are important.

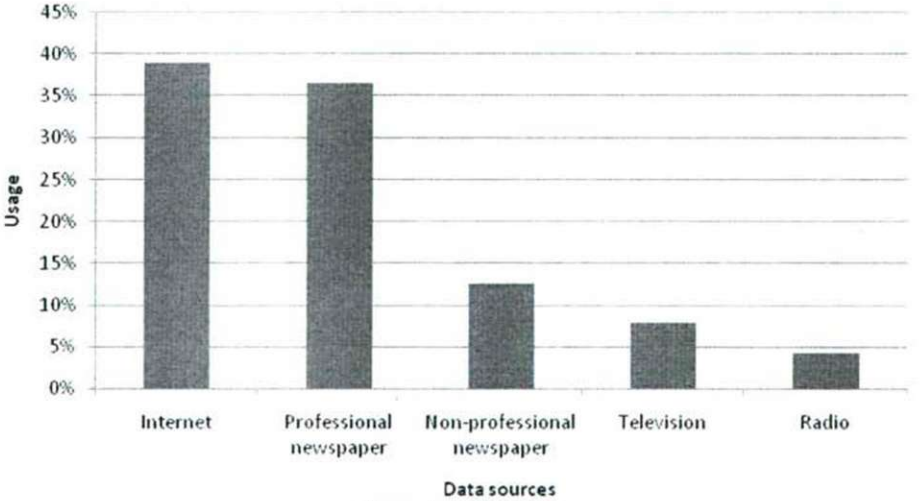

Figure 4. Public media

When speaking of government organizations one can note that the most used sources are the national organizations (40%), regional (31%) and local (29%) organizations are considered less important.

In the business environment the competitors are the most significant data sources (59%), the banks – as source of information – are less important (32%).

The other sources of data and information – at least according to the surveying in the three companies – are infrequently used. (This includes higher education institutes too.)

According to the answers of the managers, the computer aided information systems used in the three companies are mainly integrated information systems with some of the modules already working and other modules are under development or introduction. The programmes are capable to do all the necessary office work (office tasks, accounting, invoicing, stock management, supplier and customer management, logistics tasks, etc.). Formerly the companies used uniquely developed systems but now they are moving towards using standard systems.
In terms of the analysis capabilities of the information system the managers' answers did not tally. Some of them indicated that their system was able to analyse the current situation but cannot forecast, while others answered that the system was able to do both. This discrepancy may be because some are not acquainted with the capabilities of the system, or do not use those services.

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FACTORS OF INNOVATION RELATED TO HIGHER EDUCATION

Gabriella Keczer
University of Szeged, Faculty of Engineering

ABSTRACT

The European Union evaluates the member states' innovation potential and performance by the European Innovation Scorecard. According to this, in 2005 Hungary was the 18th out of the 33, among the countries catching up, but by 2006 we dropped to the 23th rank, among the countries that are trailing behind the rest. In my paper I examine our innovation potential and performance on the basis of those factors that are related to higher education. Then I give some suggestions in order to improve our position.

INTRODUCTION

In creating a knowledge-based economy we should produce such "settlement" that is obviously necessary not only for us, but also for others, and can be done locally. But in our present set of values innovation and creativity are still strange entities. (Gál J, 2006) In what follows, I will present Hungary's innovation potential and performance on the basis of an analysis of international and Hungarian statistical data, mainly focusing on factors directly related to higher education. I will consider the conditions required by universities for fulfilling their role in developing a knowledge-based economy.

1. HUNGARY'S INNOVATION POTENTIAL AND PERFORMANCE

The European Innovation Scorecard (EIS) takes 5 dimensions of innovation into consideration, 3 from the input and 2 from the output side.

A. Input dimensions:

1. Innovation drivers: human resources as the structural condition of innovation potential
-- science and engineering graduates (per 1000 inhabitants aged 20-29)
-- number of persons with a higher education diploma (per 100 inhabitants aged 25-65)
-- broadband internet access (number of broadband lines per 100 inhabitants)
-- number of participants in life-long learning (per 100 inhabitants aged 25-65)
-- youth education attainment level (proportion of population aged 20-24 having completed at least secondary education)

2. Knowledge creation: investments in research and development (R&D) activities as a condition for a successful knowledge-based society
-- state R&D expenditures (measured as a percentage of the GDP)
-- business R&D expenditures (measured as a percentage of the GDP)
-- medium-high-tech and high-tech R&D (measured as a percentage of manufacturing R&D expenditures)
-- innovative enterprises receiving public funding (measured as a percentage of all enterprises)

-- university R&D expenditures financed by businesses (measured as a percentage of total university R&D expenditures)

3. Innovation and entrepreneurship: innovation-related activities of the enterprises
-- innovative small and medium size enterprises (SME) (measured as a percentage of all SMEs)
-- innovative SMEs cooperating with one another (measured as a percentage of all SMEs)
-- innovation expenditures (measured as a percentage of the total turnover)
-- early-stage venture capital (measured as a percentage of the GDP)
-- ICT expenditures (measured as a percentage of the GDP)
-- SMEs implementing non-technological change (measured as a percentage of all SMEs)

B. Output dimensions:

4. Application: the performance expressed in terms of labour force and business activities and their added value in innovative sectors
-- employment in high-tech services (measured as a percentage of the total work force)
-- exports of high-tech products (measured as a percentage of the total exports)
-- sales of products newly introduced to market (measured as a percentage of the total turnover)
-- sales of products introduced recently by the company (measured as a percentage of the total turnover)
-- employment in medium-high and high-tech production (measured as a percentage of the total work force)

5. Intellectual property: successful achievements related to know-how
-- new European Patent Office (EPO) patents (per million inhabitants)
-- new United States Patent and Trademark Office (USPTO) patents (per million inhabitants)
-- new triadic (European, USA, Japan) patents (per million inhabitants)
-- new community trademarks (per million inhabitants)
-- new community designs (per million inhabitants)

According to the EIS, Hungary has the following performance indicators:

Based on the Summary Innovation Index (SII), in 2005 Hungary ranked 18th out of the 33 European countries scoring 0.3. This performance ranked us among those catching up. Sweden (above 0.7), Switzerland, Finland, Denmark and Germany (scoring 0.6 or above) are the EU's innovation leaders. The EU-25 average for 2005 is 0.42. Of the new member states, Estonia and Slovenia have the highest scores (above 0.3), outdoing Hungary. The trailing country is Turkey (below 0.1). Unfortunately, our indices had worsened by 2006, pushing us back in the rank to 23. We were preceded by Spain, Cyprus, Lithuania, the Czech Republic, and also Malta. (It should be noted that this set-back was mostly due to a deterioration in indices associated with small and medium-sized enterprises, rather than higher education.) This puts us to the group of those trailing behind the rest.

2. THE ROLE OF HIGHER EDUCATION IN THE PROVISION OF INNOVATION POTENTIAL AND INNOVATION PERFORMANCE

Of the above innovation factors, those directly related to higher education are the following:

- recently graduated science and engineering students
- those with a higher education diploma
- those participating in life-long learning
- patents

As regards the above factors, Hungary scored as follows:

1. recently graduated science and engineering students: 2005: 4.8; 2006: 5.1
The EU25 average in 2005 was 12.2. The highest rate was noted in Ireland (24.2), with Lithuania having the highest score of the new members states (16.3), this index being the one in which Hungary lags behind all the other countries. As far as this aspect is concerned, unfortunately, Hungary will follow a negative trend also in the longer run because the number of science and engineering students will remain at a low level, regardless of the dramatic increase in the number of students enrolled in higher education over the past 15 years. As a result, the proportions are expected to keep worsening, rather than improve.

	1990/1991	2001/2002	2002/2003	2003/2004	2004/2005
total number of students	102,387	313,238	341,187	366,947	378,466
science students	1,647	5,405	5,917	6,338	6,774
engineering students	20,223	29,443	50,590	50,368	49,945

Source: own compilation and calculation on the basis of KSH data

2. those with a higher education diploma: 2005: 16.7; 2006: 17.1
The EU25 average in 2005 was 21.9. The highest rate was noted in Finland (34.2). Hungary appears to lag behind Latvia, Lithuania, Slovenia, and Estonia of the new member states. The highest rate was recorded in Estonia (31.4).

3. those participating in life-long learning: 2005: 4.6; 2006: 4.2
The related ratio among the EU25 in 2005 was 9.9. The highest proportion of the age group taking part in such education is in Sweden (35.8). Of all the new members, only Slovakia is not behind Hungary, where a ratio similar to ours is noted. The highest rate is noted in Slovenia (17.9).

4. patents:
Patents submitted to the EPO: 2005: 18.3; 2006: 18.9
The EU-25 average in 2005 was: 133.6, the highest rate was noted in Switzerland (460.1). Of the new EU members, Slovenia ranks higher than Hungary (32.8).
Patents submitted to the USPTO: 2005: 4.9; 2006: 5.3

The EU-25 average in 2005 was 59.9, again, the highest rate was noted in Switzerland (188.3), and, also, Slovenia ranks higher than Hungary (8.4).
Triadic patents: 2005: 3.3; 2006: 1.9
The EU-25 average in 2005 was 22.3, with Switzerland being the leader again (110.8), and Slovenia ranking higher than Hungary (4.0).

A low number of patents does not indicate low performance of Hungarian researchers or research sites, rather, it points to the fact that research rarely progresses to the state that is most important in terms of innovation. I have compared ratios between the number of patents in several countries against the number of scientific papers, and the result attained appears to underlie the above statement.

	PAPER	PATENT	PAPER/PATENT
HUN	220	19	11.6
EU25	450	137	3.3
US	720	168	4.3
SWE	1180	285	4.1
SWITZ	1160	426	2.7
FIN	1000	306	3.3
GER	550	319	1.8
JAP	450	219	2.0
SPA	400	31	13.0
CZECH	225	16	14.0
SK	180	8	22.5
PORT	210	7	30.0
POL	170	4	42.5

Source: own compilation and calculation on the basis of 2003 OECD data

3. CONCLUSIONS

The above data indicates considerable lag of Hungary in a number of factors that are directly related to higher education. In order to achieve a higher rate of university contribution to the innovation output of the country and the region concerned, the following aspects merit consideration.

1. A governmental policy based on specifying the number of admissible students almost exclusively on the requirements of potential students and thus letting the number of, say, media graduates multiply by a magnitude while allowing the number of some science and engineering majors shrink is wrong also from the point of view of innovation. Numbers of students in state-financed education should be determined on the basis of the country's long-term interests and the expected labour market demand. In addition to maintaining a better proportion in this respect, the government and the institutions of higher education are required to do their best in order to steer students in public education towards science and engineering studies.

2. An obstacle to dissemination of innovative knowledge in Hungary is related to a lack of tradition to be involved in life-long learning. Such dissemination should play a crucial role in improving this situation and higher education should assume a key role in adult training, as universities represent the best natural resource for disseminating research-based and

up-to-date knowledge. To this end, universities are required to face the professional, pedagogical, and technical challenges posed by non-conventional study groups, non-traditional educational technologies, and advanced forms of training. Apparently, adult training at the university will only contribute to increasing innovation potential if students acquire a knowledge that is readily implemented in practice.

3. The decreasing (and ever lowering) number of patents is one of the clear symptoms of the fact that the results of research performed at Hungarian universities fail to reach the phase of practical implementation. Therefore, simultaneous utilization of various means is necessary for the knowledge and expertise developed at the university to directly penetrate the economy, that is, to strengthen what is called knowledge transfer. To this end, it is necessary to strengthen the relationship between the economy and the universities, which appears possible first of all at the regional level.

4. At present, universities typically cooperate on interregional, international levels, and tend to get integrated into their own region to a lesser extent. Also, they have their results implemented in practice earlier by way of mediation through international networks, compared to regional level utilization (Gál Z, 2005). Management of innovation, utilization of research output, and provision for the flow of knowledge require a separate organizational unit to be established within the university (office of innovation, technological transfer centre, a kind of clearing house), as well as involvement of universities (incubator, scientific parks, regional offices for development). It is important to streamline the main research orientations of the university that represent world class performance of the institution with the structure of the local economy, as that is indispensable for the transfer of knowledge and technology (Bajmóczy, 2005).

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HYPERFILTRATION OF RIBES NIGRUM JUICE

Szabolcs Kertész[1], Nóra Pap[4], Szilvia Bánvölgyi[3], Ivetta Vincze[3], Gyula Vatai[3], Zsuzsanna László[2], Sándor Beszédes[2], Cecilia Hodúr[2]

[1]PhD School of Environmental Sciences, University of Szeged

[2]University of Szeged, Faculty of Engineering

[3]Corvinus University of Budapest, Faculty of Food Science, Food Engineering

[4]University of Oulu, Department of Process and Environmental Engineering

KEYWORDS: reverse osmosis, concentration, blackcurrant juice, depectinization, osmotic pressure model

ABSTRACT

Blackcurrant juice is very popular among consumers due to its high content of mineral salts, C-vitamin, P-, B1-, B2– vitamin and provitamin A also. The scope of this study was to examine the applicability of a pilot scale reverse osmosis system for the concentration of different enzyme pretreated blackcurrant juice by AFC - 80 polyamide tubular membrane. With two pectinase enzyme preparation (Panzym Super E and Trenolin Rot DF) of the fresh juice for enzymatic depectinization was investigated.
For description of the concentration process and the osmotic pressure model has been used. Van't Hoff model can be applied for the calculation of osmotic pressure differences dependence on the difference of concentrate and permeate concentration. Rautenbach model can be also used, which determines the osmotic pressure in the knowledge of the concentration.

1. INTRODUCTION

Blackcurrant juice is very popular among consumers due to its pleasant taste, as well as its numerous beneficial health effects. It contains mineral salts and vitamins in a great amount. Its C-vitamin concentration is 4–5 times higher than that of the lemon. It is also rich in P -, B1 -,B2 - vitamin, in provitamin A in pigment and anthocyanins [Bánvölgyi et al, 2006]. After harvesting the berries, blackcurrants are usually processed into juices. One of the basic unit operations of fruit juice technology is the concentration process to reduce liquid volume and, therefore, storage and transportation costs. Concentration is expected to increase the total solids content (TSS) of the juice from 10 % up to 75 % by weight [Gunnar Jonsson et al, 2003].
To provide consumers with all beneficial properties of the fresh berry in the products, it is necessary to apply gentle processing method that promotes the preservation of the original characteristics of berries. In recent years, membrane processes such as nanofiltration (NF), reverse osmosis (RO) and alternative membrane based separation: membrane distillation (MD) and pervaporation have been evaluated as concentration processes in fruit juice [Fukumoto and Girard, 2000]. RO has achieved some commercial success in the fruit juice concentration: it presents the advantages of a lower thermal damage to the product, reduction in energy consumption and lower capital equipment costs. However the final concentration of juices is limited to about 25–30 °Brix due to the high osmotic pressure of the feed at those levels [Cassano et at, 2007]. Leaving out prefiltration by microfiltration (MF) or ultrafiltration (UF), and the possibility to avoid enzyme treatment is significant from economical point of view [Heinonen et al, 2001, Keiski et al, 2006].

The aim of the research was to concentrate blackcurrant juice at a pilot scale by reverse osmosis (RO). The effect of clarification by centrifugation, and an enzymatic depectinization was compared to the juice without any pre-treatment by the means of achieved final TSS content, and permeate flux during concentration. To evaluate the possibility of fouling during juice concentration, the osmotic pressure model was used, and the total resistance was calculated taking into account the membrane resistance and fouling resistance.

2. MATERIALS AND METHODS

Extraction and pretreatment of juices

The blackcurrant berries were provided by Fitomark 94 Ltd Hungary farm. Berries were treated with enzymes (pre-press pectinases by Trenolin enzyme) to ease the pressing and increase the yield. They were pressed using a Pera PN BUCHER compressor. The juice was afterwards pasteurized, clarified conventionally by centrifuging. The blackcurrant juices were depectinized by pectolitic enzyme preparations (Panzym Super E and Trenolin Rot DF). The Panzym Super E liquid preparation (pectolitic activity of 2000 FDU 55 °C/mL) is obtained from selected strains of *Aspergillus niger*. A small amount of emzymes (8 ml / 20 l) were used and the treatment time was 12 hours in the case of Panzym Super E at 25 °C, and for 24 hours and 96 hours in case of Trenolin at 25 °C and in refrigerator 6 °C, respectively.

RO unit and experimental procedures

The RO tubular B1 module, which comprises 18 perforated stainless steel tubes from Paterson Candy International (PCI) was used. Each tube is lined with a membrane element of 12.5 mm of diameter and 1.2 m length (0.9 m^2 of total area). The tubes are connected in series. The module contained AFC 80 polyamide tubular membrane. This compact tubular method has been developed to ease the concentration of highly viscous fluids. Temperature is controlled by means of a heat exchanger. After passing through the heat exchanger, the feed temperature was set to 25 °C. Then they were fed through the membrane module and recirculated back to their reservoir. The trans-membrane pressure was fixed at 60 bar, and 60 L of the juices were concentrated in each batches. Cleaning of the membranes was carried out after every test run as follows. The membrane was first rinsed by tap water at a recirculation rate of 25 L/h and trans-membrane pressure of 60 bar for 30 min. This was followed by circulating 0.1 w/w% NaOH solution at same conditions for 30 min and rinsed by tap water. Finally a 0.5 % citric acid solution has been used and circulated for 30 min, followed by rinsing with tap water. Before and after each cleaning procedure, the pure water flux was measured and used later on for the calculation of the total resistance based on resistance-in-series model.

Analytical and calculation methods

Total soluble solid (TSS) content was measured using an Atago PR-101 α digital refractometer. Measurements were made at ambient temperature. TSS was expressed as °Brix. Prior to each set of measurements, the instrument was calibrated at 0 °Brix using deionised water.

3. RESULTS AND DISCUSSION

Permeate flux during RO

The initial total soluble solid content of the feed varied between 16.1-18.9 and has been at the end of the concentration 28.2, 25.7, 25.4 and 22.4 for Panzym Super E, Trenolin Rot at 6°C, Trenolin Rot at 25°C, and Control juice respectively. Add some values, e.g. the maximum TSS of 28.2 °Brix was achieved in case of PSE enzyme pretreatment. At the same time the concentrate volume has been reduced by about one half compared to the feed volume. As it was shown in the Fig. 1, the fluctuation of TSS concentration is rather various at different pretreatment samples. During the first 100 min. the concentration was 26.6, 24.7, 24.2 and 21.7 °Brix PSE, Trenolin at 6°C, Trenolin at 25°C and the Control respectively.

In this figure also could see there is no significant difference between Trenolin samples. However the TSS of Trenolin treated juices was higher till the first 50 minutes than the PSE treated after a while this tendency changed. It seems to be the juice treated with PSE enzyme less attaches in the pores of the RO membrane therefore the fouling will occur later.

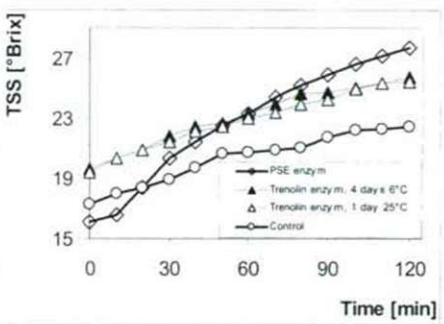

Fig. 1. Comparison of TSS values at different pretreatments.

The permeate fluxes during the concentration procedure varied depending on the feed and applied pretreatment. Permeate flux decreased with rise of TSS in the Fig. 2. When the running progressed the °Brix increased and the most abatement of flux was in the case of PSE enzyme. It was also proven that the highest decreasing rate was observed in PSE. The data are illustrated in Fig. 2 for the depectinized juices (Panzym Super E and Trenolin Rot), and the Control juice. The greatest permeate flux was achieved in the concentration of juice that has been previously depectinized by Panzym Super E treated. The achievable maximum TSS was the lowest in Control case only 22.4 °Brix contrary to depectinized samples. Therefore it is advisable that the depectinization process is carried out at room temperature as it does not require the use of extra energy opposite to refrigeration.

Shown the dynamic of the flux decline which is measured by J/J_0. The normalized fluxes (J/J_0, where J_0 is the measured initial permeate flux value [$L/(m^2h)$]) are plotted on the function of the TSS as shown in the Fig. 3. The normalized fluxes of the different pretreated juices decreased as the TSS rose which was correspond with the literature data of V. Piironen et al measuring in 2003 [Borquez et al, 2002, Piironen et al, 2003]. Since the decreasing rate of the control and Trenolin treated samples were much higher than the PSE treated sample, the application of the pretreatment with PSE is the most economically.

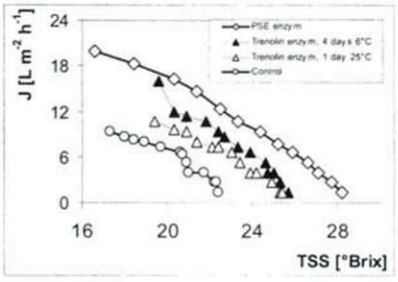

Fig. 2. The effect of TSS on the fluxes.

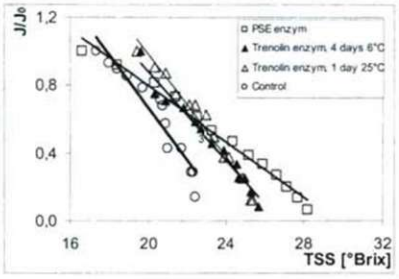

Fig. 3. The normalized flux values.

a. Mathematical modeling

The resistance model of the membrane separation defines the pure water flux as the quotient of the trans-membrane pressure – driving force (Δp_{TM}, Pa) – and the resistance (R_M, 1/m, calculated by water dynamic viscosity: η_W, Pas) arising from the pore size of the membrane – material feature.

$$J_W = \frac{\Delta p_{TM}}{\eta_W \cdot R_M} \tag{1}$$

The fouling resistance of the applied membranes can be determined from the water flux (J_F, m/s) – measured on a fixed temperature – after flushing the membrane with tap water after concentration test using the following formula:

$$R_F = \frac{\Delta p}{J_F * \eta_W} - R_M \qquad [1/m] \tag{2}$$

As it known the total resistance is composed of two resistances as:

$$R_T = R_M + R_F \qquad [1/m] \tag{3}$$

At membrane filtration of liquid mixtures the osmotic pressure model is valid which determines the flux (J, m/s) as the quotient of difference of the trans-membrane pressure (Δp_{TM}, Pa), the osmotic pressure difference ($\Delta\pi$, Pa), and the total membrane resistance (R_T, 1/m). The effect of temperature integrated is into the equation in the knowledge of the permeate (practically water) viscosity (η_W, Pas).

$$J = \frac{\Delta p_{TM} - \Delta\pi}{\eta_W \cdot (R_M + R_F)} \qquad [L/(m^2h)] \tag{4}$$

Using eqs. (1) – (3) the resistances could be calculated. The results are illustrated in Table 1. The membrane resistance was the same in all cases after effective cleaning, as it has mentioned in experimental procedure. It should be noted that the fouling resistance (R_F) was found to be an order of magnitude lower than the membrane resistance.

The highest fouling resistance was measured with Control and with Trenolin enzyme after 1 day treatment.

Table 1. Calculated resistances of different pretreated juice types.

Pretreatment	R_M	R_F	R_{Total}
Control	$2.92*10^{14}$	$1.985*10^{13}$	$3.119*10^{14}$
PSE enzyme	$2.92*10^{14}$	$1.141*10^{13}$	$3.034*10^{14}$
Trenolin enzyme, 4 days 6°C	$2.92*10^{14}$	$1.578*10^{13}$	$3.078*10^{14}$
Trenolin enzyme, 1 day 25°C	$2.92*10^{14}$	$1.962*10^{13}$	$3.116*10^{14}$

The biggest effect on fouling resistance was shown by PSE enzyme. 41.9% lower R_F value was measured in PSE treated samples than in the case of Control. On the other hand, the fouling resistance seemed not to be determining in the matter of permeate flux, because it is an order of magnitude lower than the membrane resistance, since there was hardly any difference between the total resistances. On the basis of previous statement, the permeate flux can be expressed by using the simplified form of eq. (4):

$$J = \frac{\Delta p_{TM} - \Delta\pi}{\eta \cdot R_M} \qquad [L/(m^2h)] \qquad (5)$$

It is possible that the glucose molecules in the boundary layer near the membrane play a role in the creation of the osmotic pressure. The van't Hoff model can be applied for this phenomenon which determines the osmotic pressure dependence on the difference of concentrate (c_R, kmol/m^3) and permeate (c_P, kmol/m^3) concentration. R=8314.472 J/kmolK universal gas constant, T=298.15 K temperature of experiment.

$$\Delta\pi = (c_R - c_P) \cdot R \cdot T \qquad [Pa] \qquad (6)$$

Next to the van't Hoff model, the two variables (a, Pa; n, -) Rautenbach model can be used, which determines the osmotic pressure in the knowledge of the concentration (c, Brix°).

$$\pi = a \cdot c^n \qquad [Pa] \qquad (7)$$

By introducing the modified exponential equation of Rautenbach model, where the concentration of the permeate side (c_P) was not taken into consideration, the following formula is obtained:

$$\Delta\pi = a \cdot c_R^n \qquad [Pa] \qquad (8)$$

By the combination of the equations above, the following one is obtained. Taking its logarithm and introducing the pure water flux (J_W, m/s), the two variables can be determined plotting log (J-J_W) versus log c_R (*Table 2*).

$$J = J_W - \frac{a}{\eta_w \cdot R_M} \cdot c_R^n \qquad [L/(m^2h)] \qquad (9)$$

Table 2. The coefficients of Rautenbach-model

Pretreatment	a [10^5 Pa]	n [-]
Control	0,3331	-5,0579
PSE enzyme	0,4161	-5,1885
Trenolin enzyme, 4 days 6°C	0,5637	-5,4005
Trenolin enzyme, 1 day 25°C	0,4161	-5,1885

In the case of the mathematical modeling of the experimental process the Rautenbach model with the exponential relation was better than the van't Hoff one in both processes. The parameters of the experimental relation include the features of the membrane and the raw material.

The reason for under estimation of the osmotic pressure in case of the van't Hoff model could be the fact that it was calculated only on the basis of sugar concentration; even it is well known that the other components of the juice also influence the osmotic pressure of the juice. For these calculations a detailed analysis of the concentration of juice components is necessary which makes the mathematical modeling complicated. The Rautenbach equation is more simple, even empirical but suitable for description of the results of laboratory experiments and useful for designing the pilot and small industrial equipments.

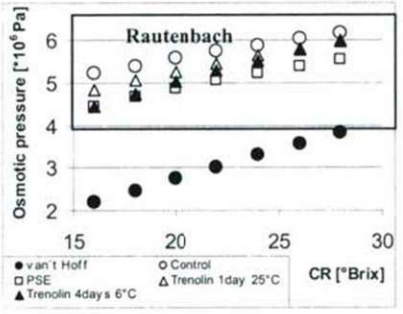

Fig.4. Calculated osmotic pressures by Rautenbach and van't Hoff model.

Higher calculated osmotic pressures were shown by empiric Rautenbach model than van't Hoff (Fig. 4), but lower in case of depectinized samples. This allegation is just more or less true, because in fact the membrane and fouling resistances were determined but the macro and micro solids resistances were not examined during the concentration. Inasmuch the content of TSS was not known exactly, the normative model is the Rautenbach and the measured fluxes of the Rautenbach are the relevant (Fig. 5-6).

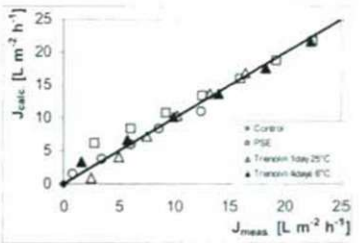

Fig.5. Deviation of calculated and measured fluxes by Rautenbach model. The line is the calculated flux.

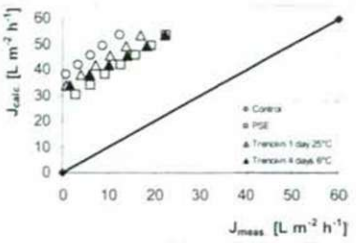

Fig.6. Deviation of calculated and measured fluxes by van't Hoff model. The line is the calculated flux.

4. CONCLUSIONS

The different enzyme pretreatment, with two commercially available pectinase enzymes preparation (Panzym Super E and Trenolin Rot DF) of the fresh juice for enzymatic depectinization was investigated in the interest of different pectinase effects. The highest concentration ratio was observed in case of PSE pretreatment. The total soluble solid content of the concentration was risen 28.2, 25.7, 25.4 and 22.4 for Panzym Super E, Trenolin Rot at 6 °C, Trenolin Rot at 25 °C and Control juice respectively. The highest permeate flux of 20 L/(m^{2}h) and TSS of 28.2 °Brix was achieved in the concentration of juice that has been previously depectinized by Panzym Super E. There has not been significant differences of the two Trenolin treatments in the terms of permeate flux, therefore it is advisable that the depectinization process is carried out at room temperature as it does not require the use of extra energy opposite to refrigeration.
It has been concluded that reverse osmosis was viable method for concentration of blackcurrant juices with the applied membrane at 60 bar trans-membrane pressure and 30 °C operating temperature.
The depectinization effects of PSE and Trenolin enzymes were obvious, which decreased the different resistances and increased the flux. PSE mighty decreased the fouling, while the reduction was lower in presence of Trenolins.

Since the glucose molecules in the boundary layer near the membrane play a role in the creation of the osmotic pressure, van't Hoff model can be applied for this phenomenon which determines the osmotic pressure dependence on the difference of concentrate and permeate concentration. Next to the van't Hoff model, Rautenbach model can be used, which determines the osmotic pressure in the knowledge of the concentration.
Higher calculated osmotic pressures were calculated by empiric Rautenbach model than van't Hoff and the relevant model was the Rautenbach.
The measured flux values and the calculated fluxes using van't Hoff model were significantly difference which all goes to show this model should not apply for Ribes nigrum juices using Rautenbach model is recommended for this kind of process modeling.

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CONSUMERS' FAMILIARITY WITH SPECIAL-QUALITY AMARANTH PRODUCTS

Ágota Panyor
University of Szeged, Faculty of Engineering

ABSTRACT

Unhealthy nutrition has grave consequences. Diseases of nutritional origin (gastrointestinal diseases, chronic metabolic diseases, asthma, cancer, various deficiency diseases) are becoming more and more common. Therefore certain groups of people turn increasingly to conscious nutrition, as part of which foods with natural materials are preferred. Amaranth products produced organic also belong to this system.

1. INTRODUCTION

Amaranth is more and more frequently encountered as a rediscovered raw material, first of all in non-traditional diets. Amaranth can be classified into the group of pseudocereals, which means that although taxonomically it does not belong to the family of grains, it is included among them because its floury seeds with a high starch content are hulled and ground, similarly to grains.
The advantages of amaranth include that its cultivation is simple, it tolerates dryness and can be grown in chemical-free organic production (Kripner, 2006). Amaranthussp is used for nutritional purposes, it is one of the most ancient cultivated plants in the history of mankind, it witnessed the flourishing and the fall of the Aztec and Inca empires. It originates from the place where corn, potato, pepper, tomato and bean came to Europe. Before America was discovered, it served as a staple food, together with corn and bean, for the peoples living there. Its deliberate cultivation dates back to 5-6000 years ago. Its importance at that time is confirmed by the record according to which Montezuma – the last Aztec emperor – received an annual amount of 5000 tons of corn and 3700 tons of amaranth seeds from his subjects as tax.

Conquerors arriving from Christian Europe looked upon amaranth as a means of barbaric rituals, and in order to put an end to it, Cortez banned the cultivation of amaranth in 1519. Thus amaranth was pushed back into the hidden mountain villages of South and Central America, where its cultivation was continued until it was "rediscovered" again a few hundred years later. Interest in amaranth has been revived since the 1970s when NASA researchers discovered its useful inner content values and incorporated amaranth in the astronauts' diet (Szőcs, 2004).

Nutritional-physiological value of amaranth seed and its utilization in food industry

During the past 30 years the advantageous physiological properties of amaranth seed were confirmed by several examinations. Both Hungarian and foreign examinations revealed that the average protein, fat, fibre and mineral content of the seeds of various amaranth varieties is higher while their carbohydrate content is lower than in traditional

grains. When the inner content of amaranth is examined and compared with that of wheat and other grains, a number of significant differences can be observed. (Table 1)

Table 1 Comparison of the inner content of amaranth with that of other grains

Grain type	Protein (%)	Lysine proportion (%)	Carbohydrate (mg/100g)	Calcium (mg/100g)	Iron (mg/100g)	Magnesium (mg/100g)
Amaranth	16	6.7	63	240	10	280
Wheat	10	2.9	71	41	3.3	20
Amaranth/ wheat	160%	231%	89%	585%	300%	1400%
Corn	9	2.5	74	20	1.8	7
Rye	13	4.0	73	38	2.6	-
Buckwheat	12	5.8	72	33	2.8	-
Rice	7	2.7	77	32	1.6	13

Its protein content is 20-60 % higher while its carbohydrate content is 10-15 % lower than that of other grains. The further examination of protein reveals that lysine, which is an amino acid of great importance in muscle building and regeneration, is present in considerably larger quantities than e.g. in wheat. Another extremely important property of amaranth is that its proteins contain practically no gluten, so flour-sensitive persons can also consume it. The amaranth seed (particularly the germ and the shell of the seed) is rich in minerals, it contains five times more iron, seven times more calcium and four times more zinc than wheat flour, and its magnesium content is also very high (Léder, 2000). Its magnesium content is all the more noteworthy because magnesium is a substance with a role in preventing infarction. As regards its vitamin content, its ground seed contains vitamin C in addition to vitamins B and E, characteristic of grains.

The amaranth seed can be ground, like the seeds of other grains. Similarly to them, several grounds can be obtained: *germ flour*, *whole grain flour* and *traditional flour*. The latter two types of flour can be used in all kinds of products and food, just like ordinary wheat flour or rye flour. The only essential difference concerning preparation is that leavened dough (bread, milk loaf, scones, etc.) cannot be prepared from amaranth flour alone as gluten-forming proteins are absent from it. For this reason it is usually blended with wheat flour. These blends are much more valuable than their components alone. The proportion of amaranth flour is usually below 30 % in the blend.

Amaranth flour is not as white as wheat flour, its colour is rather light grey. Its odour is determined by the oil it contains, and its feel is also oily, sticky in a powder-like way. The customary flavour of the products (bread or cake) made from blended flour is changed by the addition of amaranth hardly at all. It is rather the texture of the product which changes, it becomes more compact, oilier in character and more filling. Compared with ordinary recipes, less oil or margarine is needed. Such products retain their freshness for a longer time, they dry and age more slowly than products made from pure wheat flour. This is especially noticeable in the case of various breads (Jánoska, 2003).

Amaranth seeds can be ground to flour, in addition to which they also offer a wide range of nutritional applications in a *popped form*. It can be used in several foods, including morning cereals, breadcrumbs for meat, fish or poultry, confectionery products (when added to chocolate, it enhances flavour and texture), salad dressings (e.g. popped amaranth strewn on salads), bakery products (breads, tea cakes, cookies, biscuits), extruded snacks, chips, pastas, healthy food, soups and dietary products.

2. MATERIALS AND METHODS

Applying the marketing research principles and methods, laid down by Lakner and his co-workers (Lakner and Sass, 1997; Szabó et al.,1998; 2000;)

In spring 2006, we asked consumers in two organic shops in Szeged and in one in Budapest about their familiarity with and consumption habits of amaranth products, with the help of the questionnaire method.

3. RESULTS

186 customers were questioned during the survey, and only 34 % of them knew amaranth products. This relatively low proportion shows that even conscious biofood consumers are relatively unfamiliar with the amaranth plant and with the products made from it. As to the composition of the consumers, it was found that typically women wishing to adopt a healthier lifestyle in the family's diet purchase these products. These families consist of three members on average, the majority of them have higher school qualifications, most of them a university or college degree. Basically, the customers' income falls into the medium earnings category, consequently amaranth products do not classify as luxury products (they are typically in the medium price bracket).

Customers in organic shops are the most familiar with popped amaranth (67.8 %), then with natural seed and finally with amaranth flour. (Fig. 1)

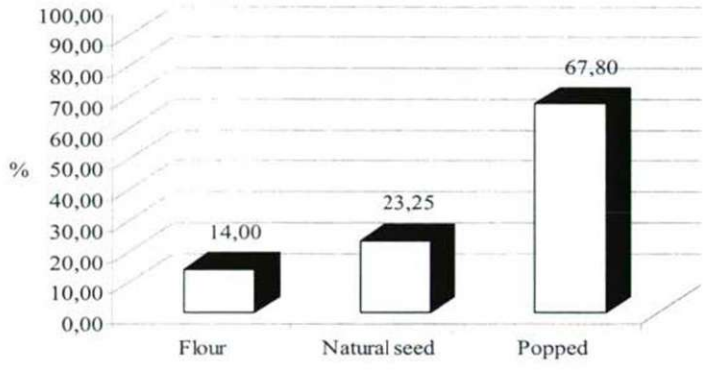

Figure 1. Familiarity with amaranth products in percentage of answerers

The greatest part of costumers first met the products while looking around in bioshops, only few of them were recommended amaranth products by doctors or natural therapists. The people questioned had practically never seen or heard advertisements or other marketing means.

The answers given to the questions on the consumption habits of *amaranth flour* revealed that it is used almost exclusively to improve bread and cakes, supposedly because of the recognition of the positive physiological properties of the product. The typical quantity consumed is 1-3 bags a month (0.5-1.5 kg) for most of the answerers.

Natural amaranth seed is most commonly used as garnish. Besides, it is also used in soups and as an enricher when baking bread. A monthly amount of 3 bags (0.75 kg) is consumed on average.

Popped amaranth is the most widely used amaranth product. It is the most frequently used for enriching mueslis, but it is often consumed with milk, dairy products or in itself, too. Some consumers incorporate it in various foods such as meatballs, salads, home-made cheese, etc. An average family consumes 1-3 bags (10-30 dkg) a month.

An important aim of our survey was to find out how satisfied the consumers are with certain properties of amaranth products. (Table. 2) The answerers could evaluate the properties of the products known by them on a 5-degree scale.

Consumers were the most satisfied (a score of 4.28) with the packaging of the products. Larger packagings would be welcome by customers who consume a greater quantity of popped amaranth. Some of them would like to buy a smaller packaging of flour as they use only a smaller quantity.

The packing of amaranth products as a function to protect the product was not disapproved of. However, many customers missed resealable packing materials, which would ensure to preserve quality after opening. This would be important especially in the case of flour and popped amaranth as they become rancid soon after opening.

Table 2 Evaluation of the properties of the products on a 5-degree scale

Factors	Average	Standard deviation
Packaging	4.28	1.263
Packing	4.17	1.251
Availability	4.13	0.932
Price	4.10	1.185
Information on physiological effects	3.92	1.198
Choice	3.78	1.246

The availability of the products was satisfactory for the customers asked (average score of 4.13). The customers are aware that amaranth products can be purchased only in bioshops. However, some of them would prefer their sale in a wider range; they would like to see these products on the shelves of supermarkets, too.

The price of the products was marked with an average score of 4.1. The majority of the customers did not object to the prices, on the one hand possibly because there are no similar, comparable products. On the other hand, the relatively low quantity consumed does not involve great costs, and in our opinion consumers would be willing to pay an even higher price for more processed products.

The average score given to the question concerning information on the physiological effects was 3.92. Customers obtain information mostly from the labels on the packing; unfortunately other possible means of communication and promotion hardly care to provide more information or to propagate the positive aspects of amaranth products.

The answerers were the least satisfied with the choice (average score of 3.78). They would like to see the enlargement of the available product choice. This could be expected in advance, that is why the question regarding the reception of potential new products was included in the questionnaire. The answers given to this question are evaluated in Figure 2.

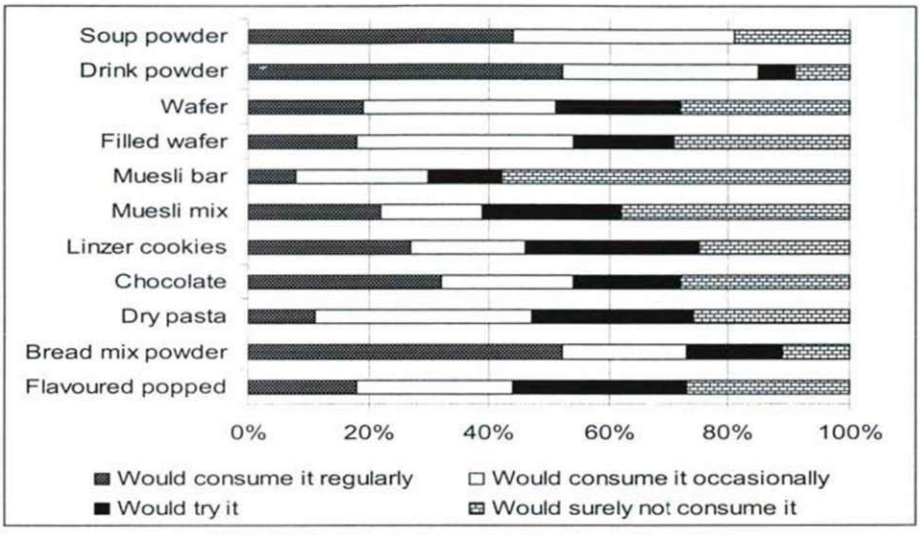

Figure 2. Customer's responsiveness to new products

It is clear from the answers that various powdered products would be the most welcome (soup, drink and bread mix powder). In our opinion these products could even be classified into a group of convenience products, the demand for which represents new challenges and market possibilities for participants in the food industry.

Chocolate would also be received favourably by the customers questioned, it could be popular especially with families with children. However, one must remember that packing should be youthful as appearance and design are important for children.

There was smaller interest in muesli mixes, probably because most people prepare their own similar mixes themselves. Popped amaranth, however, is usually included in the mix prepared according to taste.

The reception of wafer, Linzer cookies, dry pasta and flavoured popped amaranth is uncertain. Most of the answerers would not mind consuming them, but at the same time only few of the customers asked in the survey would consume them regularly.

4. CONCLUSION

First the nutritional advantages of amaranth seed were discussed during our work, and then an attempt was made to assess the habits of amaranth consumption with a questionnaire survey. It is clearly shown by the results obtained that even biofood consumers are familiar with amaranth to a small extent only. Therefore it would be extremely important to put greater emphasis on various means of marketing during the distribution of the products and to extend the range of consumers with the help of intensive marketing activities.

This in turn could enhance production, and the increased demands on the consumers' part could give possibilities for small and medium-sized enterprises by increasing the product range.

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PECTIN EXTRACTION FROM BLACKCURRANT PRESS CAKE

Nóra Pap[2], Sándor Beszédes[1], Szabolcs Kertész[1], Zsuzsanna László[1], Eva Pongrácz[2], Riitta L. Keiski[2], Gábor Szabó[1] and Cecilia Hodúr[1]

[1]University of Szeged, Faculty of Engineering, Department of Technical and Process Engineering, Moszkvai krt. 5-7, HU-6725 Szeged

[2]University of Oulu, Department of Process and Environmental Engineering, Mass and Heat Transfer Process Laboratory, P.O.Box 4300, FIN-90014 University of Oulu

Keywords: pectin, blackcurrant press cake, solvent extraction, microwave-assisted extraction, recovery

ABSTRACT

The efficiency of microwave activation process in the extraction of pectin from blackcurrant press cake was investigated in this study. Conventionally, pectin extraction is a time-consuming and energy-intensive process. In our experiments, microwave enhanced extraction (MAE) method was used. The applied specific power levels were 5, 10, 15 and 25 W/g, and the processing time applied was between 10-40 minutes. As a control method, conventional hot water extraction (at 80-90°C) was used. The effect of pH on pectin yield was also investigated in both cases. The pectin content was measured by spectrophotometer at 520 nm by the m-hydroxydiphenyl method and was expressed as galacturonic acid equivalent.

The effect of time, pH of the solvent, solid-liquid ratio and the specific microwave power level on the extractable pectin content have been studied. The experiments demonstrated that MAE reduced the extraction time from 9 h to 30 minutes, while the yield of pectin increased. It was concluded that MAE is a viable method for the recovery of valuable compounds from blackcurrant juice processing by-product.

1. INTRODUCTION

Natural pectin is a structural unit of fresh cell and a junction between the cells advanced land plants. It exists between the cell walls and its function is to agglutinate the cells to form a compact junction. The pectin consists of a-D-galacturonic acid components, which are partially esterified with methyl alcohol at carboxylic acid end. In industrial applications, pectin is widely used in food and pharmaceutical industry as gel-forming and texturizing agent.

The most used raw materials of commercial pectin extraction processes are apple, orange, sugar beet, berries (e.g. blackcurrant). I the case of the latter, the by-product of blackcurrant juice pressing, contains a great deal of valuable components such as pectin, which are worthwhile to recover.

The commercial pectin extraction processes are based on degradation by acid and deposition. These processes are a very time consuming, taking from 1 to 12 h, and have a large liquid phase demand. In these processes an acidic solution is used, by applying sulphuric, phosphoric, nitric, acetic or hydrochloric acid, and a temperature range from 80 to 100 °C. These conditions may also result in protein degradation and, therefore, they can negatively affect both the quantity and the quality of extracted pectin. These reasons have led to the application of improved, rapid extraction processes, such as microwave assisted extraction (MAE) (Manabe et al., 1988).

In recent years, MAE attracted a growing interest, as it allows rapid extractions of solutes from solid matrices, with extraction efficiency comparable to that of classical techniques. In this type of extraction, microwave energy is used to heat solvents in contact with samples to extract valuable and soluble compounds from the sample into the extractant, such as pectin from apple pomace (Wang et al., 2007), lime (Marshall et al., 2006) and orange peels (Zhongdong et al., 2005 and Kratchanova et al. 2004).

The microwave energy is a non-ionising radiation (frequency 300-300000 MHz) that causes molecular motion by migration of solvent ions in electromagnetic field and rotation of dipoles of polar molecules, such as water (Jones et al., 2002). The efficiency of microwave energy is dependent on the dielectric properties of solvent and the sample. As strongly polar solvent, water can efficiently absorb the microwave energy and transform it into thermal energy, leading to rapid heating of the sample.

Microwaves heat the sample without heating the vessel, therefore the solution temperature rapidly increases leading to a very short extraction time. During microwave irradiation the cells are thermally stressed, the temperature and pressure in the cell will exceed the maximum and the cell walls are ruptured. Thus the skin tissues are opened up by the microwaves more rapidly and extensively than in the conventional hot water method (Zhongdong et al., 2005).

In our work, we investigated the effect of extraction time, pH, liquid to solid ratio and the specific microwave power on the yield of pectin from blackcurrant press cakes by MAE, and compared the MAE method to the conventional hot water and acidic hot water extraction methods.

2. MATERIALS AND METHODS

The moisture content of the blackcurrant press cake was 64.5%. The moisture content was determined by drying 10 g of sample at 105 °C for 24 h in a drying cabinet.

For the conventional extraction, an Armfield (Hampshire, Great Britain) pilot solvent extractor was used. The solvent was water at 80 °C, with pH 6.18 without any adjustment, and water adjusted with aqueous hydrochloric acid solution to pH 2. The quantity of sample was 100 g and the solid-liquid ratio was 1:40.

For MAE a single-mode cavity resonator was used, at a frequency of 2.45 GHz. The microwave power of the magnetron is continuously adjustable between 100 and 700 W. The treatments were carried out in a covered PTFE sample holder to prevent evaporation during the irradiation without pressure increase. Temperatures were measured with an infrared thermometer.

The specific microwave power level was changeable by varying the power of the magnetron and using different sample quantities. The specific power levels applied were 5, 10, 15 and 25 W/g wet weight, and the experiments were carried out during 10 to 40 minutes. The solid-liquid ratio varied between 1:5 – 1:20.

The extracted pectin content was measured photometrically at 520 nm by the *m*-hydroxydiphenyl method adapted from Ibarz et al. (2006), and expressed in GA units. A standard curve absorbance/concentration was fitted with the absorbance values at 525 nm from different series of D-galacturonic acid concentration solution. A blank tube with no D-galacturonic acid content was also prepared. The pectin sample was obtained from the blackcurrant extracts, and the water-soluble pectin (WSP) was determined as follows. A sample of 0.1 mL was added to a 15 mL assay tube. In the case of the WSP 0.5 mL of extract and 0.5 mL of distilled water were added followed by the addition of 5 mL of the sulphuric tetraborate solution and placed in a ice-water bath. The mixture was shaken in a vortex mixer to homogenize the sulphuric solution. The cold bath prevents excessive warming, allowing a higher control of the time of the hot sulphuric reaction.

The tube is then placed in a water bath of 80 ± 0.5 °C, for 6 min and then immediately placed in the water-ice bath until reaching room temperature. Further, 0.1 mL of m-hydroxydiphenyl solution was added and, after a vortex stirring to homogenise the mixture, spectrophotometric absorbance at 520 nm was carried out, with absorbance readings being taken at different times.

In some cases, the pectin content was precipitated with isopropanol; a 50-ml sample was washed with 2×150 mL isopropanol, and the precipitated gel was filtered off, dried for 24 h at 30 °C, and then measured by spectrophotometer. All analyses were performed in triplicate.

The energy demand of extraction processes was calculated from the power of magnetron and the filament of the extractor with the following formulas:

$$Q_{extraction} = P_{max} t_{heating} + P_{heater} t_{extraction} \quad [1]$$

$$Q_{microvawe} = P_{magnetron} t_{extraction} \quad [2]$$

3. RESULTS AND DISCUSSION

Firstly, commercial hot water and acidic hot water extraction was investigated for the extraction of pectin residues, and the pectin content of the extracts was determined. The results of the extracted water-soluble pectin content for 8 hours' duration of extraction are depicted in Figure 1.

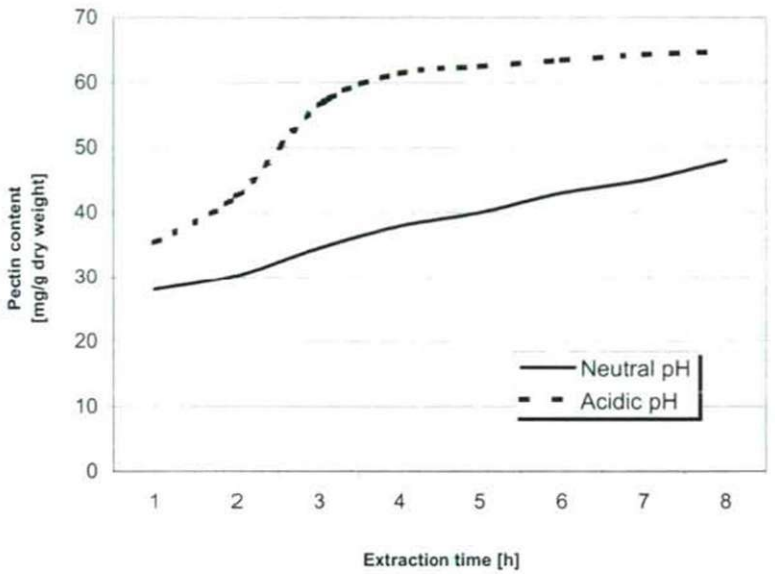

Figure 1. Pectin content of the extracts in hot water and acidic hot water extraction processes

Figure 1 illustrates that there was no saturation value in the conventional hot water extraction during the 8 hours of treatment. The connection between the extraction time and pectin yield was linear during the examined interval. When hot water adjusted with hydrochloric acid to pH 2 was applied for the extraction, the pectin yield showed an increasing tendency in the first 4 hours of extraction time, where the curve reached a saturation point.

In the next series of our measurements, the pectin yield from black currant press cake was investigated by applying microwave assisted extraction process. The effects of microwave power level, solid to liquid ratio and the pH of solution were investigated.

Figure 2 illustrates the effect of specific microwave power levels on pectin extraction. The applied specific microwave power was between 5 - 25 W/g changed by adjusting the power of magnetron.

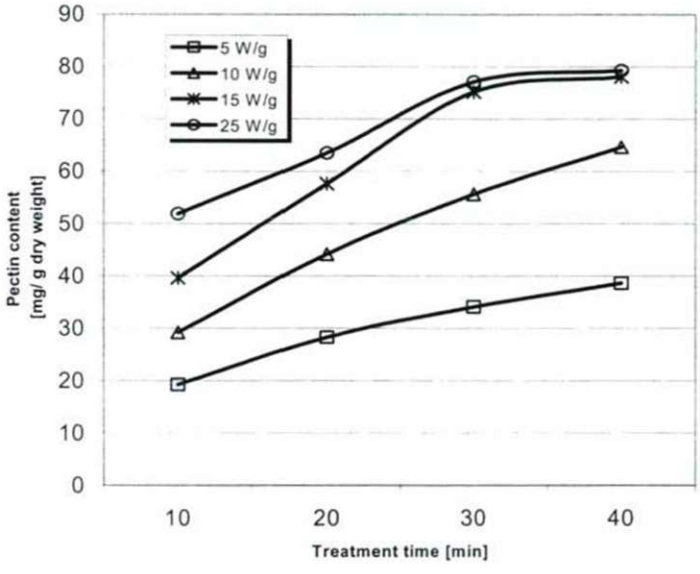

Figure 2. Influence of specific microwave power on extracted pectin content (solid to liquid ratio 1:10)

Pectin yield increased with treatment time and increasing microwave power. After the 20 minutes treatment a linear trend was measured when the applied specific power level was 5W/g and 10W/g. At 15 and 25 W/g specific microwave power levels, a saturation value in the pectin yield was reached after 30 minutes. The benefit of the application of higher specific microwave power level was an intensification effect in the beginning of extraction. However, since after 30 minutes the extracted pectin content was the same at 15 and 25 W/g, it was concluded that, further, the maximum power of 15 W/g is to be used.

In another series of experiments, the influence of solvent to solid ratio on the pectin content of the extracts was examined. MAE was carried out using water as a solvent with 5:1, 10:1 and 20:1 solvent to solid ratio. Because of the low pectin yield at 5 W/g microwave extraction and the similarity of the values of pectin content at 15 and 25 W/g the results of 10 and 15 W/g MAE were illustrated on Figures 3 and 4.

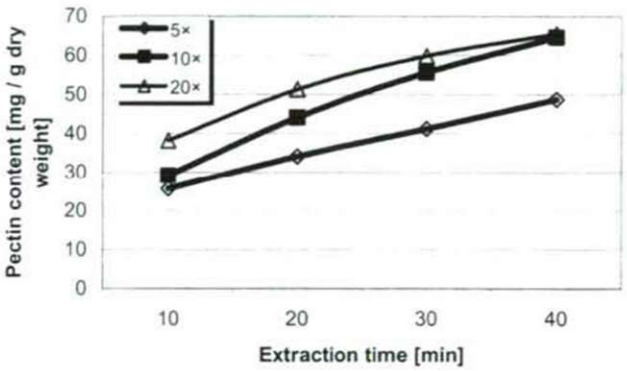

Figure 3. The influence of solvent to solid ratio on the yield of extraction at 10 W/g microwave power level

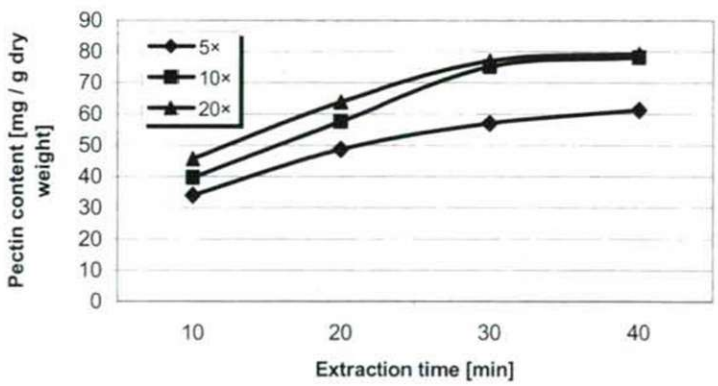

Figure 4. The influence of liquid to solid ratio on yield of extraction at 15W/g microwave power level

As Figures 3 and 4 indicate, the higher liquid to solid ratio the higher the extracted pectin was. Higher extraction level was reached with 15 W/g, however, after 30 minutes of irradiation there was no significant yield difference between tenfold and twenty fold dilutions. Therefore, it was deduced that the 10:1 solvent to solid ratio is optimal.

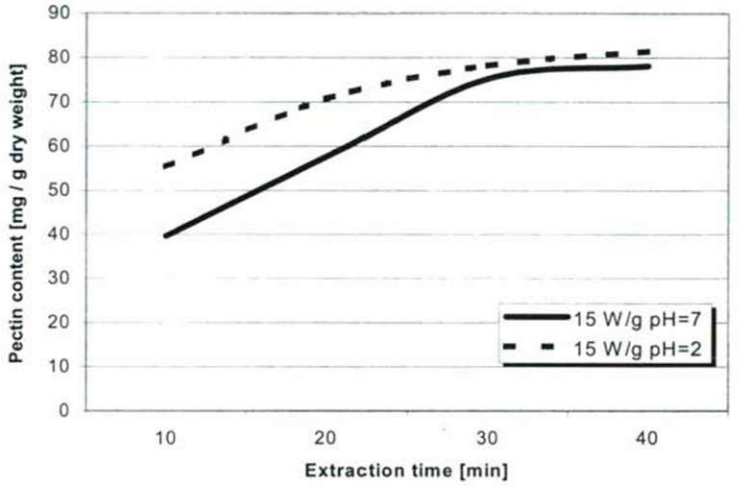

Figure 5. The influence of pH of the solvent on pectin yield at 15W/g power (liquid to solid ratio 10:1)

Finally, the influence of the pH of solvent on the extracted pectin yield was investigated at 15 W/g power level and liquid to solid ratio was 10:1. The pH of the solvent was adjusted either to pH 2 or to pH 7. The results are illustrated in Figure 5.

As Figure 5 illustrates, at pH 2 the pectin yield was higher, however, after 30 minutes, there was no significant difference between the amounts of extracted pectin at as compared to the solvent sample at pH 7. However, since the structure of pectin can be easily damaged at low pH, we concluded that the extractions are better to be carried out at pH 7. In this way the use of auxiliary materials can also be avoided.

Finally, to evaluate the efficiency of different extraction methods, the energy demands were calculated. The results are depicted in Figure 6.

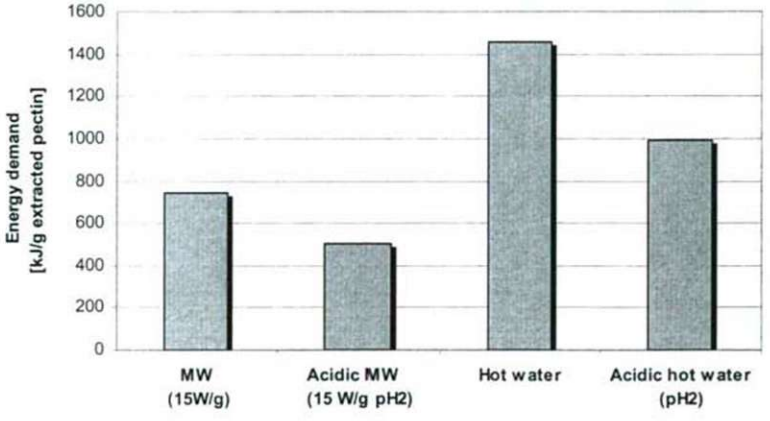

Figure 6. Energy demand of different extraction methods

From the aspect of energy demand, MAE is clearly less energy-intensive when compared to hot water extraction. In both extraction methods, lowering the pH of the solvent decreased the energy demand of the process. Notwithstanding, the extraction at pH 7 is recommended, when using MAE, the addition of acid can be avoided, as the energy saving is not so substantial, and at neutral pH the pectin quality is expected to be better.

4. CONCLUSION

Microwave heating accelerated the extraction of pectin from blackcurrant press cake. Our experiments show that, as compared to hot water extraction, microwave assisted extraction reduced the processing time from 6-8 h to 30 min, the pectin yield was higher and, the liquid phase demand could be lowered.

It can be concluded that the best operational parameters of pectin recovery from blackcurrant press cake by MAE are 15W/g specific microwave power level, 30 minutes extraction time, 10:1 solvent: solid ratio and pH 7.

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EXPERIMENTAL STUDY OF HEAT AND MASS TRANSFER IN POROUS SPHERES DURING DRYING

Erika Simon
University of Szeged, Faculty of Engineering
Department of Mechanical and Process Engineering

ABSTRACT

The heat and mass transfer was studied in case of porous material. The models were spheres which were made in different sizes from gypsum and the mixtures of gypsum and paper. The weight loss, the water content and the temperature of the product were tested on different air velocities during each experiment. The physical properties of the samples were measured in the interest of determination of heat transfer data.
The calculated heat transfer coefficients on the basis of measured data have shown a difference from the results of heat transfer data – including dimensionless equations - derived from literature. The mass transfer was studied during the steady-state period and the results confirm the tendency the dimensionless Sh equations suggested in the literature.

1. INTRODUCTION

Drying means the removal of the moisture content from a wet, solid material by turning a part of this moisture into gas state. The drying conditions influence the quality of the dried product. These conditions are the gas velocity, the inlet gas temperatures and humidity and the drying time. In analyses of the drying, convective transfer coefficients are important parameters for the prediction of drying rates and temperatures.
Some studies presented experimental results about the coupling heat and mass transfer phenomena around different shaped materials. After considering the transport coupling effects, experimental results from loss of moisture and surface temperature indicate several ways to calculate the heat transfer coefficients using dimensionless numbers. The coupled heat and mass transfer results are correlated in terms of the dimensionless Nusselt and Sherwood numbers. The simple shapes of the dried materials were plates and cylinders made of porous material.
Some research carried out that the free stream turbulence has an effect on the heat transfer coefficients in case of plate, circular cylinder and elliptical cylinders. (Kondjoyan et al., 2002; Kondjoyan and Daudin, 1995). Fig. 1. shows four experimental results of the effect of turbulence intensity on heat transfer. The transfer coefficient increases according to the free stream turbulence level either in the laminar boundary layer or in the turbulent boundary layer (Kondjoyan and Daudin, 1993).

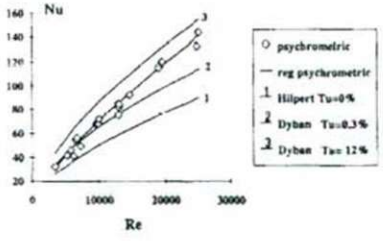

Figure 1. The effect of turbulence on heat transfer Nu at cylinder (Kondjoyan and Daudin, 1993)

Others found that the measured heat transfer coefficient is twice larger than the coefficient predicted for heat transfer only (Szentgyörgyi et al., 2000; Sun and Marerro, 1996). See Figs. 2 and 3.

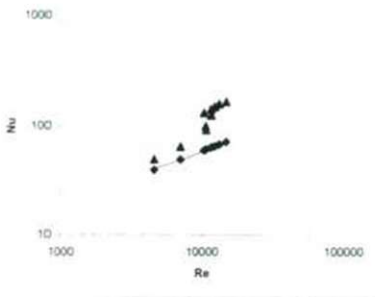

Figure 2. Nu numbers derived from experiment (▲) and calculated from literature (♦) for plates [4]

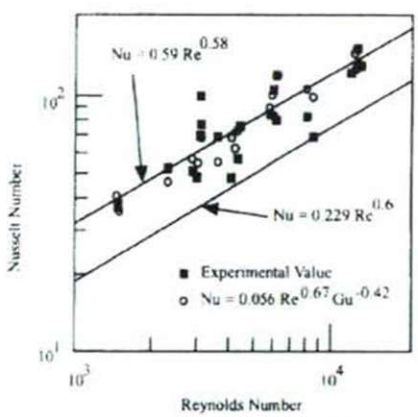

Figure 3. Nu numbers derived from experiment ($Nu=0,59Re^{0,58}$) and calculated from literature ($Nu=0,229Re^{0,6}$) and a corrected Nu for cylinder [5]

The aim of our work was to study the heat and mass transfer around single spheres during convective drying using a correction method with a dimensionless number.

2. MATERIALS AND METHODS

Apparatus and drying conditions

The experimental way used in this study adopted from (Kondjoyan and Daudin,1993). A horizontal drying chamber was made for this study. The cross-section of the chamber was 0.1 m^2. The chamber operated with a fan. The fan was placed in the inlet pipe, and this inlet pipe contained filaments to warm up the drying air. The air temperature was kept on a constant level at each experiment. The air velocity was controlled on a constant level. The experiments were repeated four or five times with the same sized sphere on a different velocity level.

The drying material was placed onto a special frame in the area of free stream. The frame had tripod standing outside of the chamber on a balance. By this way, the weight loss of the sphere was under on-line control. The inlet air temperature, humidity and the pressure-drop were measured at the inlet pipe. The air temperature in the drying chamber and the inside temperature of the sphere were measured by a sensor and thermocouples. All parameters were registered on a computer.

Material

The materials used in the experiments were different size of spheres which diameter was 29 mm; 38 mm; 41 mm. These spheres were made of gypsum and gypsum mixed with paper. Three thermocouples were inserted into the spheres: into the middle, near the surface and one between these. The prepared spheres were put under water to hydration for eight hours before the experiments.

Theoretical analysis

During convective drying, simultaneous heat and mass transfer exist. The drying process consists of three main periods: the first is the 'developing' period; the second is the 'constant rate' period and the third one is the 'falling rate' period. This study pays attention on the constant rate period.

The correction method was used to define the heat and mass transfer coefficients in the constant rate period of the drying. In this period, the surface of the material is supposed to be covered totally by water. Therefore, the surface temperature is equal to the wet bulb temperature at any point of the body. The wet bulb temperature depends on the air temperature and the humidity.

In coupling transport phenomena, the heat flux coming from the hot, ambient air turns into the phase change of the moisture content of the material and otherwise increases the temperature of the drying material.

In the constant rate period, the heat is assumed to turn into evaporation of the moisture content of the material and the increase of the temperature inside the material is negligible:

$$\phi_h = \phi_m \cdot L_{vap} \tag{1}$$

Where:

$$\phi_h = h \cdot (T_G - T_{sp}) \tag{2}$$

$$\phi_m = k^{'} \cdot \rho_G \cdot (Y_s - Y_G) \tag{3}$$

The moisture flux across the sphere can be estimated from the weight changes during the constant rate period:

$$\phi_m = \frac{1}{A_{sp}} \cdot \frac{dm}{dt} \tag{4}$$

Using the Eqs. (2) and (4), the heat transfer coefficient can be calculated.

$$h = \frac{\phi_m \cdot L_{vap}}{T_G - T_{sp}} \tag{5}$$

With the heat transfer coefficient derived from the measured data, the Nusselt number is:

$$Nu = \frac{h \cdot D_{sp}}{\lambda_G} \tag{6}$$

There are Nusselt numbers proposed by (Inncoropera and DeWitt, 1995) and (Környey, 1999) with which the heat transfers could be described around a single sphere.

$$Nu_{lit,1} = \left[2 + \left(0{,}4 \cdot \mathrm{Re}^{1/2} + 0{,}06 \cdot \mathrm{Re}^{2/3}\right) \cdot \mathrm{Pr}^{0{,}4}\right] \cdot \left(\frac{\eta_G}{\eta_{sp}}\right)^{0{,}24} \tag{7}$$

A special case of convection heat transfer from spheres relates to the heat transport from freely falling drops. The Eq. (8) is suggested by (Inncoropera and DeWitt, 1995).

$$Nu_{lit,2} = 2 + 0{,}6 \cdot \mathrm{Re}^{0{,}5} \cdot \mathrm{Pr}^{0{,}33} \tag{8}$$

Introducing a dimensionless group, the Eq. (7) and (8) can be improved. The Gukhman number, see Eq. (9), is published by (Luikov, 1964).

$$Gu = \frac{T_{G\infty} - T_{wb}}{T_{G\infty}} \tag{9}$$

The suggested dimensionless Nu-relation:

$$Nu_{Cor} = Nu_{lit} \cdot Gu^{n} \tag{10}$$

The mass transfer coefficient was determined by Eqs. (3) and (4) without using any analogy to estimate it from the heat transfer.
The Sherwood number was calculated by:

$$Sh = \frac{k' \cdot D_{sp}}{D} \tag{11}$$

There are Sherwood numbers proposed by (Inncoropera and DeWitt, 1995) and (Szentgyörgyi et al., 1986) with which the mass transfers could be described around a sphere. Eq. (12) describes the mass transfer around a single porous sphere:

$$Sh = \left[2 + \left(0{,}4 \cdot \mathrm{Re}^{1/2} + 0{,}06 \cdot \mathrm{Re}^{2/3}\right) \cdot Sc^{0{,}4}\right] \cdot \left(\frac{\eta_G}{\eta_{sp}}\right)^{0{,}24} \tag{12}$$

Eq. (13) can be used to predict the mass transfer around freely falling drops.

$$Sh = 2 + 0{,}6 \cdot \mathrm{Re}^{0{,}5} \cdot Sc^{0{,}33} \tag{13}$$

Eq. (14) predicts nearly the same for sprayed liquid drops or sphere shaped solids.

$$Sh = 2 + 0{,}55 \cdot \mathrm{Re}^{0.5} \cdot \mathrm{Pr}^{0.33} \qquad (14)$$

3. RESULTS

The constant rate period is well observable from the weight loss of the sphere. The weight of the wetted, gypsum sphere decreases consistently until 30 minutes, see Fig. 4, marked with ♦-line. As assumed before, the evaporation is characteristically for the constant rate period therefore the temperature of the material is constant. This shows well the Δ ○ ◊-marked lines on the Fig. 4.

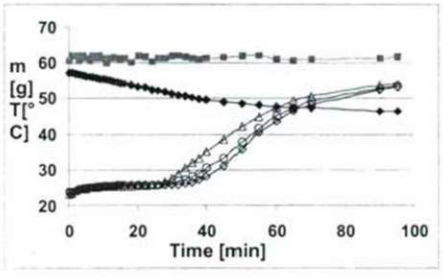

Figure 4. Drying parameters of the sphere

(diameter 41 mm and air velocity 2,39 ms^{-1} ; ■ air temperature 60°C): ♦ m-weight loss;

Δ ○ ◊: Ts-inside temperature of the sphere

The calculated Nusselt numbers are significantly higher than the Nusselt numbers predicted by the equations found in the literature. The same discrepancy was found earlier in case of green peas during fluid bed and tray drying. (Simon, 2007) The Nusselt numbers published before took into consideration the heat transfer only. The calculated Nusselt numbers denote here the simultaneous heat and mass transfer. Introducing the dimensionless Gukhman number, suggested by Luikov, the corrected Nusselt number taken from the literature can be improved, see Eq. (9). After determination the exponent of the Gukhman number the Eq. (15) was resulted.

$$Nu_{Cor} = Nu_{lit} \cdot Gu^{-0{,}69} \qquad (15)$$

Every predicted value of the Eq. (15) is closer to the experimental values than those calculated from Eqs. (7) and (8), see Figs. 5 and 6.

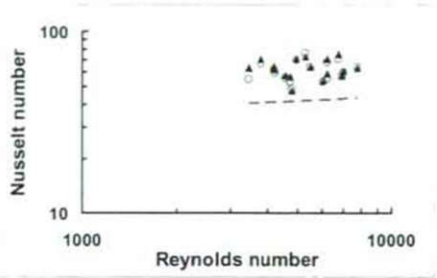

Figure 5. Nusselt numbers as a function of Reynolds number for single spheres in drying: ▲-experimental values used Eq. (6); ○-Nu_{Cor}=f(Re, Pr, Gu) with Eq. (15).; dashed line means $Nu_{lit,1}$ derived from Eq. (7).

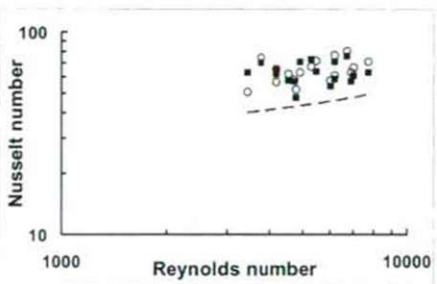

Figure 6. Nusselt numbers as a function of Reynolds number for sphere-like drops: ▲-experimental values used Eq. (6); ○-Nu_{Cor}=f(Re, Pr, Gu) with Eq. (15).; dashed line means $Nu_{lit,2}$ derived from Eq. (8).

The deviations of the corrected Nusselt numbers from the experimental Nusselt values are given in Fig. 7. Deviation was defined as follows:

$$Deviation = \frac{Nu - Nu_{Cor}}{Nu_m} \qquad (16)$$

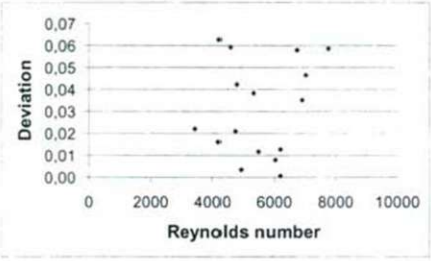

Figure 7. The deviation of the corrected Nusselt numbers from the experimental values

In the case of mass transfer, there is no significant difference between the experimental data given and the calculated ones based on the literature.

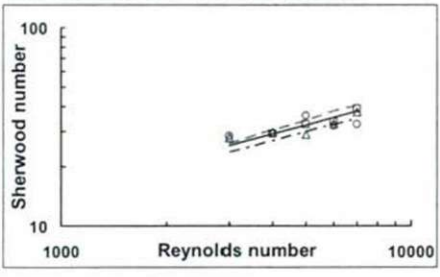

Figure 8. Sherwood numbers as a function of Reynolds number for spheres in drying:

○□Δ-experimental values used equation 11;

- - -/-·-·-/—: lines using Eqs. (12)/ (13)/ (14)

The Sherwood numbers defined from the experimental values are below the Sherwood numbers predicted from the literature in Fig. 8. This similarity of the Sherwood numbers could thank to the continuously evaporation in the constant rate period. The Eqs. (12-14) predicted Sherwood numbers only for mass transfer without any influence of heat transfer. Therefore the experimental data seem to support the accuracy of the equations taken from the literature in case of the spheres in the given Reynolds range.

4. CONCLUSIONS

The heat and mass transfer coefficients analysed at convective drying by correction method across single gypsum and gypsum-paper spheres. The measured heat transfer coefficient is larger in the same Reynolds range than the coefficient predicted for heat transfer only. Introducing the Gukhman number, the Eq. (15) gives more accurate Nusselt number to predict the heat transfer coefficient for the coupled heat and mass transfer.

Nomenclature

D_{sp}	diameter of the sphere [m]
D	water diffusivity in air [$m^2 s^{-1}$]
A_{sp}	surface of the sphere [m^2]
m	weight of the sphere [kg]
T	temperature [K]
T_{sp}	inner temperature of the sphere
L_{vap}	latent heat of evaporation [J kg^{-1}]
Y	moisture fraction [kg kg^{-1}]
h	heat transfer coefficient [W m^{-2} K^{-1}]
k'	mass transfer coefficient [m s^{-1}]
v	air velocity [m s^{-1}]

Greek symbols

ϕ_m	moisture flux [kg m^{-2} s^{-1}]
ϕ_h	heat flux [W m^{-2}]
η	dynamic viscosity [kg m^{-1} s^{-1}]
λ	thermal conductivity [W m^{-1} K^{-1}]
ρ	density [kg m^{-3}]
ν	kinematic viscosity [$m^2 s^{-1}$]

Dimensionless groups

Nusselt number	hD_{sp}/λ
Sherwood number	$k'D_{sp}/D$
Reynolds number	vD_{sp}/ν
Schmidt number	ν/D
Prandtl number	ν/a

Subscripts

s	surface condition
G; ∞	free stream condition of the drying air
lit	taken from the literature
wb	wet bulb condition

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REGIONAL COOPERATION IN IMPLEMENTING A WASTE MANAGEMENT PROJECT

Ferenc Szabó
University of Szeged, Faculty of Engineering

ABSTRACT

A precondition for the successful implementation of the ISPA/Cohesion Fund project entitled „Regional Waste Management Program of Szeged" and adopted in 2000 was the establishment of a project-based region with a population of 250 thousand inhabitants as the beneficiary of the said project. In this paper, I studied the experience obtained so far in connection with the establishment of regional cooperation, together with a review of the opportunities for further long-term cooperation.

1. INTRODUCTION

Accession of Hungary to the European Union has created a major opportunity for developing the infrastructure related to environmental protection. As early as in the beginning of the accession process, some EU resources were made available, and, from the year 2000, a considerable increase in funding has taken place (ISPA). Today, as a full member state of the European Union, Hungary is entitled to utilize common Cohesion Fund resources. These resources can be utilized under extremely strict conditions, a prerequisite for accessing them being in almost every case some kind of regional cooperation or regional integration. The old traditions of cooperation based on natural and mutual benefit had died off over the years of socialism. In the period of dictatorship, cooperation only existed in a form controlled from above and mostly subjected to the subordination and super-ordination relations imposed by a hierarchy of power. The majority of these relations became disrupted in the period following the change of the political regime, and was replaced by mistrust in and repugnance to any kind of integration efforts. Within a short while, however, the EU-initiated projects facilitated the creation of new forms of regional cooperation and the formation of project-based regions.

2. OPERATION DEFAULTS IN REGIONAL PUBLIC ADMINISTRATION FOLLOWING THE CHANGE OF THE POLITICAL REGIME

The change of the political regime brought with it a considerable increase in the autonomy of individual local governments. The law on local governments granted a number of new scopes of competence to the elected general meetings, the board of representatives of each settlement, including full political and pecuniary self-dependence. While a part of these rights had in principle been granted already in the single-party ("council-based") period, their exercise in practice was nearly impossible owing to full implementation of the central will. Contrary to local governments of the settlements, county-level local governments (earlier referred to as "councils") have lost their power, their competence and opportunities decreased dramatically, their activities became reduced to operating some institutions and assets remaining under county-level

supervision. One can argue, in general, that cooperation offers more advantages to the participants than disadvantages. Of course, that is true only if correct relations are maintained both internally and among the participants, with no participant trying to take advantage of his current situation or power. That was not the way things were managed during the period of socialism, so that unfavourable experience from the past coupled with an air of mistrust hindered integration processes considerably. However, the general world-wide tendency to promote and aim at integration appears to clearly demonstrate an increase in added value resulting from integration. This trend is best exemplified by the
European Union itself, on the one hand, and regionalism, which is one of the most important principles of integration in the European Union, on the other hand.

3. ESTABLISHING THE PROJECT REGION

As of 1999, the then available but officially unpublished criteria regarding project application required that a region of at least 250 thousand inhabitants and a budget exceeding EUR 5 million be targeted for the project to receive support. The latter criterion was easily met, however, in the case of Szeged, a total of 165 thousand inhabitants represented the beneficiaries. The organization of a waste management project region commenced on the basis of the guidelines of the Independent Department of International Support of the Ministry of Environmental Protection and the Delegation of the EU to Hungary. The objective was to set up a consortium comprising Szeged and the surrounding smaller settlements as project partners, whose purpose was to find a solution for the development of waste management in the region and establish long-term cooperation in order to prevent or eliminate pollution of the environment caused by wastes. There are 32 settlements located to the west of the Tisza river and to the south of the Maros river, within a 30 kilometre circle of Szeged. In the beginning, the majority of those settlements were reluctant to join the proposed project region. Following a period of several months of harmonization discussions and after the Local Government of Szeged had assumed a definitive obligation to assume all costs arising during project implementation, including the expenses related to design and preparation, as well as the provision of 10% of the project budget as own contribution, it was possible to have all the local governments concerned adopt and sign a Consortial Agreement.

3.1./ Consortial Agreement

The Consortial Agreement imposes obligations exclusively regarding the Local Government of Szeged, whereas the smaller partner local governments appear to assume liability only in certain particular issues, and only at the level of letters of intent. All in all, they agreed to support the development activities directly affecting them (waste courtyards, waste collection islands, remediation of contaminated areas and dumping grounds), to take over the public utility assets to be created as a result of development and, perhaps, to joining the mutual integrated waste management system that is to be set up at a later time.

3.2./ Financing the project

The party commissioned to implement the project was the Waste Management Public Benefit Company of Szeged, the public service provider owned by the Local Government of Szeged, the hosting organization of the Consortium. The costs arising were also covered by the said business entity. A coverage for the several hundred million HUF connected to preparatory activities and own contribution was provided by the fees collected by the waste management public service of Szeged. In other words, all the costs related to developing the infrastructure of regional waste management were borne by the population of Szeged. In the course of project preparation, experts from the European Union reviewed, as part of a cost-benefit analysis, the issues of project financing in detail, including not just the period of investment but also that of operation at a later time. Based on a cash-flow analysis prepared for a 25-year period of operation, they concluded that the investment project cannot be financed in the long run from the rate of revenue realized in 1999, especially taking into consideration that the approximately 350 million HUF yearly depreciation of the public utility assets worth more than 6 billion HUF (and its accounting will be strictly requested by the European Union). According to their calculation, an immediate 100% increase in the public service fees of waste transport then (2000) collected may provide sufficient means for implementing the project and maintaining operation in the long term. Taking such a radical step appeared impossible both amid the prevailing political relations and because of the inhabitants' limited load-bearing capacity, therefore the Local Government of Szeged adopted the below compromise. In order to double the real value of public service fees collected in 1999, the General Meeting assumed an obligation to increase the average fee by 10% above the rate of inflation over the period between 2000 and 2007. An agreement was made with the experts of the European Union, according to which such an obligation would provide sufficient guarantee to satisfy the financial feasibility criterion, thus they submitted the project in Brussels with their support, providing the above condition was met.

4. TENSION AMONG THE LOCAL GOVERNMENTS OF THE REGION

4.1./ Differing public service fees

The project is approaching its end, and the fees in Szeged have by now in fact doubled in terms of real value, while the fees collected in the surrounding settlements, which had otherwise been lower compared to those in Szeged, increased by a rate in proportion with that of inflation as a maximum. This actually means that an inhabitant residing in or renting an average home in Szeged pays approximately twice as much as an inhabitant of a small settlement located at a distance of as much as 30 kilometres from the city (which involves a considerably longer route of transportation). This situation turns out to be especially clumsy in cases where the service provider is one and the same entity (the Waste Management Public Benefit Company of Szeged), because an inhabitant of Szeged is right when asking why he needs to pay more, and why not just the opposite is true: why is it cheaper to collect waste from a longer distance. The service provider has identified the issue of maintaining identical public service fees for regional waste management services as a priority. Almost all service contracts concluded with the various local governments include a provision regarding catching up with the fees paid in Szeged. However, since fees are determined exclusively by the

general meeting or the board of representatives of the local governments concerned, the company responsible for the operation has no other possibility than to accept their decision, and has only limited (persuasion, some kind of pressure) to influence their decision. The objective that has been proposed includes a kind of regional tariff union to be set up for the coming five-year period, which means the application of identical fees within the region, regardless of the actual distance involved.

4.2./ Disputes over remediation

The process of remediation of dumping grounds on small settlements has been delayed considerably, first of all owing to difficulties in, and the complexity of the related permission procedures, and also due to a shortage in domestic governmental resources of funding. The Hungarian government agreed with the representatives of the EU in 2006 on financing the remediation activities from a separate national programme, therefore, the issue of remediation has been eliminated from the Waste Management Programme of Szeged officially. Although these tasks will be performed, contrary to the original schedule, only in 2008, things have changed favourably and the activities are now expected to be completed by the end of the first half of 2009 through 100% subsidy and no need for own contribution by the local governments. The local governments concerned appear to promote the completion of remediation as soon as possible because, in most cases, the validity of environmental permissions has expired and no more waste can be delivered to those dumping grounds. While everyone appears to be keen on starting and ending remediation activities within the shortest possible time, there is a conflict between the smaller local governments and the representative of the host partner Szeged, as the former keep blaming the representative for the delay, in spite of the prevailing circumstances. A specific situation has developed regarding the operation of the dumping grounds. The Local Government of Szeged purchased ownership rights for the territory of all such premises in order to perform the licensing procedure necessary for remediation in accordance with the Hungarian building provisions currently in force. The lengthy procedure of preparatory activities, however, has resulted in a number of problems. When affecting the transfer of ownership rights, Szeged only wanted to assume the task of remediation of the dumping grounds, and did not intend to take over the tasks connected to the operation of the dumping grounds as well. Even the mere costs of remediation amount to several tens of million HUF, but the settlements concerned contributed to it with no moneys at all. Now there are some local governments proposing that Szeged, the new owner of their dumping grounds, operate these premises until the completion of their remediation and, if additional costs should arise, even in the period that follows. In other words, they expect Szeged to prevent illegal waste delivery to the grounds, provide for guarding them, have the areas surrounded by a fence, extinguish any fire that may break out, and ensure that the regulations pertaining to dumping grounds are followed (including landscaping, earth covering, establishment of protective belt ditches). Considering the 32 settlements concerned, the related costs may reach as much as several hundred million HUF. This means that some of the local governments expect Szeged to have the citizens of the city pay for the costs of elimination of environmental pollution caused by the waste deposited on those settlements over several decades. They also expect Szeged to provide, free of charge and to the maximum extent, for the appropriate conditions of operating those dumping grounds as required by current EU regulations, conditions which they failed to grant over the past decades. That is, they wish these costs to be borne also by the citizens of the city of Szeged through the fees which they pay, because

a legal explanation of the situation that has resulted from the necessary transfer of ownership rights even allows for such an interpretation.

5. COMPLETION AND FURTHER OPERATION OF THE PROJECT; ESTABLISHING A LOCAL GOVERNMENT ASSOCIATION

The ISPA/Cohesion Fund project entitled the „Regional Waste Management Programme of Szeged" is coming to an end. According to information provided by the Development Directorate of the Ministry of Environmental Protection and Water Management, the public service assets created in the course of subsidized investment become, in line with the effective support regulations of the European Union, the property of the local governments involved, and are to remain their property for a period of at least 10 years. The Consortium that was set up earlier upon the recommendation of the Delegation of the European Union to Hungary and the Independent Department of International Support of the Ministry of Environmental Protection and Water Management (the legal predecessor of the Development Directorate) — whose establishment was a precondition for submitting the project proposal documentation — is not a legal entity, therefore it cannot carry out independent business activity, thus it is legally unsuitable for taking over and managing the assets. Hence, according to the harmonized position of the governmental bodies and the European Union, the issue of ownership of the assets can be legally resolved in a way that is acceptable to the EU requirements through establishment of a local government association. In accordance with the official position of the Development Directorate, the Consortium that was set up in order to implement the project needs to be transformed into an association of the local governments involved so that a legal background is provided to settle the issue of ownership and management of the public service assets created through support from the European Union.

5.1./ Ownership rights within the Association

The Association as an organization representing an independent legal entity will be the owner of the public service assets created as a result of joint development activities. The ownership of the undivided common property is shared among the local governments participating in the Association in proportion to their respective share of liabilities. Common liabilities and costs are shared among the participants, by default, on the basis of the proportion of the population. By contrast, in the case of the Regional Waste Management Programme of Szeged, all costs so far have been borne by Szeged alone. As regards costs that will incur in the future, the local governments will have to perform payments to be determined in line with the number of inhabitants.

5.2./ Provision of basic service, management of the public service assets

According to the Consortial Agreement, the provision of basic service and the management of the public service assets is the duty of the public service provider owned by the Local Government of Szeged, the hosting organization of the Consortium. In pursuance of the Association Contract, the Association will acquire an undivided common ownership share in the Waste Management Public Benefit Company of Szeged, consequently, the Company will be entitled to extend waste transportation public service on the public administration territory of the member local governments of

the Association without a need for announcing a public procurement tender, and also to manage the ISPA assets representing the common property of the Association.

The investment is shared among the local governments according to territory as follows:

- The regional waste management infrastructure is predominantly implemented in the Szeged region, within the public administration limits of Szeged. A part of the waste courtyards and waste collection islands have been established on the territory of the smaller local governments. This accounts for less than 10% of the whole investment.
- Remediation is performed on those waste dumping grounds of the smaller local governments which contaminate the environment; therefore this project does not directly impact Szeged. This aspect has a relevance because, according to the earlier agreement, the related costs are borne exclusively by Szeged.

6. SUMMARY

The strict regulation pertaining to environmental protection, imposed as a result of legal harmonization with the European Union, forced the Local Government of Szeged (actually, the public service provider, a business organization fully owned by the Local Government of Szeged) to elaborate designs for the technical protection and additional insulation of the Central Waste Disposal Plant of Szeged back in 1997 and 1998. Availability of ISPA funds in 1999 opened the way towards implementation; however, strict regulations of the European Union required that further conditions be met. A project region of a population of 250 thousand inhabitants had to be established; an integrated waste management model for the region thus created had to be worked out, in which insulation of the Central Waste Disposal Plant represented only a part of the global project. The Local Government of Szeged was compelled to assume all organization work and bear all related costs in order to obtain the support of the European Union for the several billion HUF investments. The smaller local governments and the 32 nearby settlements looked upon the idea of regional cooperation with mistrust, presumably as a result of earlier unfavourable experience, which made them suspicious and were reluctant to accept the city's approach as bringing benefit to them. Following lengthy preparatory activities and a lot of persuasion, those involved finally managed to sign the consortial agreement. Although the smaller local governments received considerable amounts through the project:

- infrastructure – HUF 20-30 million on the average,
- remediation - HUF 200 million per local government on the average,

they bore and still bear no costs and assumed no obligations whatever. They do not appear grateful for there being some entity that takes care of the issue of remediation of the waste dumping grounds of the smaller local governments which contaminate the environment, which is one of the priority issues for the majority of Hungarian local governments. They appear to abuse Szeged's emergency situation resulting from the fact that the additional technical protection of the Central Waste Disposal Plant could not be postponed any longer, which represented a task that is even beyond the own capacity of a local government of a city as large as Szeged. Transforming the Consortium into an association representing an independent legal entity will create a new situation. Joint ownership and operation of an integrated waste management infrastructure created through support by the European Union and the Hungarian Government, and a public service business enterprise may open up new perspectives regarding cooperation.

An expansion of the Association by way of inclusion of further local governments may develop into cooperation at an EU region level (involving the counties of Békés, Csongrád, and Bács-Kiskun), which may appear to the European Union as a project region that is easier to handle, thus it may attract further support from the European Union.

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Resource documents:

Consortial Agreement of the ISPA project „Regional Waste Management Programme of Szeged"
The ISPA project „Regional Waste Management Programme of Szeged" Documentation
The ISPA project „Regional Waste Management Programme of Szeged" Financing Memorandum and Agreement on Support
The ISPA project „Regional Waste Management Programme of Szeged" Tender documentation.

PHYSICO-MECHANICAL INVESTIGATIONS ON DIFFERENT WINTER WHEAT VARIETIES

Balázs P. Szabó
University of Szeged, Faculty of Engineering

SUMMARY

In Hungary the wheat flour is the basic food product. The flour consumption is reducing in the last years and changes the claim the compound of the flour. The consumption of the fine flour is increase, so the baking industries have to use fine flour. Grain texture (hardness) in wheat (*Triticum aestivum* L.) is a major determinant of end-usage.
Wheat kernel hardness determines quality, flour yield, flour particle-size, water absorption and other quality characteristics of cereals. The hardness is determined by the degree of adhesion between various components of the starchy endosperm cells of the mature wheat grain, notably between starch granules and matrix (gluten) proteins but also between proteins and cell walls.
The aim of my research was to determine the kernel hardness with new static methods. To the static methods I used the Lloyd 1000 R Testing Machines and the Instron 5581. I determined the kernel hardness with the well-known and recognized method also. It was the Perten Single Kernel Characterization System (SKCS) 4100 device, NIR technic and the Perten 3303 lab mill. They are the dynamic methods. Registered and widely used Hungarian wheat varieties were applied in the study. It was 23 different winter wheat varieties (13 of HRWW and 10 of SRWW). The samples were labelled with code number. My aim was to compare these methods.

1. INTRODUCTION

There are three parts which make up the wheat kernel: the endosperm, the bran, and the germ. The endosperm is the largest part of the kernel and takes up eighty-three percent of the kernel's mass. The wheat bran is the outer coat of the kernel and, therefore, is a very good source of fiber. It comprises about 14.5 percent of the kernel's mass. The wheat germ is the sprouting section or embryo of the wheat. It makes up about 2.5 percent of the total kernel mass.
Wheat genetics is more complicated than that of most other domesticated species. Some wheat species are diploid, with two sets of chromosomes, but many are stable polyploids, with four sets of chromosomes (tetraploid) or six (hexaploid). (Hancock, James, 2004)
Greenwell and Schofield (1986) extracted proteins associated with the surfaces of starch granules from hard and soft wheat cultivars using sodium dodecyl sulphate (SDS). They named this protein friabilin.
Kernel texture is very strongly heritable in wheat. In other words hard wheat will always be hard, and soft wheat will always be soft, no matter where or when it is grown. If a series of wheat varieties of different hardness are grown in different locations and/or different seasons they will retain their order of hardness with minor changes. The friabilin protein determines the kernel hardness.

A recent French study allowed distinguishing between consequences of hardness and vitreousness. Hardness is suggested to influence the adhesion forces between starch granules and protein matrix whereas vitreousness would rather be related to the endosperm microstructure (Grefeuille et al, 2006).

2. MATERIALS AND METHODS

The aim of this research was the investigation of winter wheat varieties. I investigated the kernel hardness in wheat varieties widely used in the Hungarian agriculture.

Materials

23 entries (registered wheat varieties) of bread with diverse technological qualities were used in this study (13 of HRWW and 10 of SRWW). The entries produced in the year of 2005 and 2006 in Szeged, Hungary and were evaluated for various quality characteristics.
Clean grain samples were used to identify the hardness index (HI) by SKCS-4100 instrument (Perten Inc.) and the NIR hardness. Grain samples then were grinded by Perten 3303 for establishing the grinding energy using a 1-phase output indicator interface.

Methods

The Perten SKCS 4100 instrument is one of the well know machines, which examine the kernel hardness. This device measures kernel texture by crushing the kernels one at a time, recording the force required to crush the kernel, and reporting the average force for crushing 300 kernels, in terms of a hardness index (HI). (Szabó, 2006)
The most practicable reference methods include the Particle Size Index (PSI) methods, using Perten 3303 mill. The Lab Mill 3303 is a disc type mill for grinding of grains, peas, maize, soybeans and other products with low fat content. This involves grinding a sample, and sieving a weighed amount (usually 10g) through a standard screen for a standard time. (Gyimes, et. all., 2002) The percentage of throughs is recorded as the PSI. I determined the grinding energy with this machine.
I determined the maximum breaking force, the break work, the Young's modulus with the LLOYD 1000 R Material Testing Machines and Instron 5581. I examined the grain in standing and prone position. To the standing position II scraped the grain, the surface on the side of the beard and the germ and this machine presses the kernels with the compressor head of Lloyd 1000 R testing machine of 1000 N force, and by reading the force – displacement curve. From this graph I read the breaking force, the incline and the break work. This method is a new invention. I measured the samples of 2005 with the Lloyd machines and the samples of 2006 with the Instron.

3. RESULTS

The four parameters of the static tests were: the incline, the maximum breaking force and the break work and the Young's modulus. (Table 1, Table 2)

Table 1.

The results of the Young's modulus , break work and other account traits of the wheat samples (2005)

Code	E (N/mm²)	Max breaking force (N)	Incline (°)	Break work (N*mm)	E (N/mm²)	Incline (°)	Max breaking force (N)	Break work (N*mm)
311	578,41	246,822	49,0735	53,851	96,919	29,77	112,43	19,61
320	661,812	288,58	54,18	64,588	99,03	31,24	107,58	18,265
321	712,78	294,284	54,77	60,428	108,2	33,77	120,64	18,69
322	679,149	285,76	52,601	63,12	102,23	33,14	117,41	18,396
325	596,905	268,0168	50,228	66,99	102,99	29,81	98,89	14,94
331	568,08	246,2	49	64,862	108,08	30,94	103,85	20,346
307	914,579	394,695	57,828	101,09	121,75	36,388	126,93	11,99
374	751,98	369,968	55,365	91,887	123,9	37,53	118,72	13,69
376	698,734	407,863	55,96	100,787	115,25	35,21	114,98	12,55
378	841,56	408,38	56,75	106,78	133,23	35,57	135,05	18,85
379	787,211	421,77	54,887	105,542	114,29	32,188	111,71	12,48
389	653,84	313,14	50,927	76,66	142,71	36,43	120,71	12,66

Standing position — Prone position

Table 2.

The results of the Young's modulus , break work and other account traits of the wheat samples. (2006)

Code	E (N/mm²)	Max breaking force (N)	Incline (°)	Break work (N*mm)	E (N/mm²)	Incline (°)	Max breaking force (N)	Break work (N*mm)
II.	1010,99	123,81	31,85	14,98	83,76	25,83	73,47	9,52
III.	1726,72	211,21	46,17	26,6	96,81	28,34	91,79	12,6
VI.	1193,7	160,22	36,52	20,55	80,15	25,22	81,61	11,63
IX.	1287,68	162,14	34,54	23,25	87,84	26,56	91,7	18,76
IV.	1884,78	260,82	46,77	41,265	103,86	34,04	103,31	10,78
VII.	1563,73	239,46	41,82	41,57	107,75	31,83	107,12	11,67
VIII.	1810,62	282,35	46,13	50,001	111,43	31,92	109,19	12,99
X.	2049,02	367,45	51,82	74,82	129,2	39,15	140,76	12,65
XI.	2087,371	343,89	50,204	66,457	128,51	37,41	125,05	11,4
XII.	1985,99	309,26	50,67	55,85	108,69	31,92	103,65	14,17
XIII.	2133,84	358,27	52,48	68,01	132,39	35,31	154,78	22,73

Standing position — Prone position

The SKCS 4100 compartmentalize the results in two groups. Under 50, the entries belong to Soft Wheat-, while entries above values 50 considered as Hard Wheat category. I measured the entries of 2005 with the NIR machines also. I measured the entries of 2006 with a Perten mill and determine the grinding energy.

In 2005 there are six hard winter wheat varieties (71-91) and six soft winter wheat varieties (24-46). The averages are 38 in soft and 79 in hard winter wheat varieties. In 2006 there are four soft winter wheat varieties (20-36) and seven hard winter wheat varieties (57-81). The averages are 28 in soft and 70 in hard winter wheat varieties. I used twin correlation to determine the connection, the significant level was 5 %.
The correlation between the SKCS hardness index and the NIR hardness is 0,954.
The correlation between the SKCS hardness index and the grinding energy is 0,991.

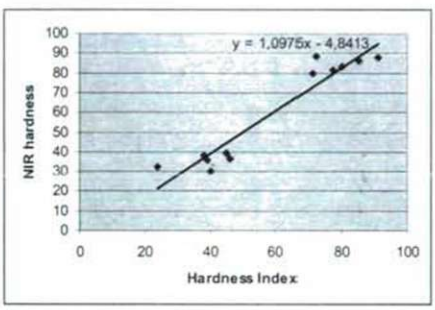

Figure 1. SKCS 4100 hardness index and NIR hardness connection

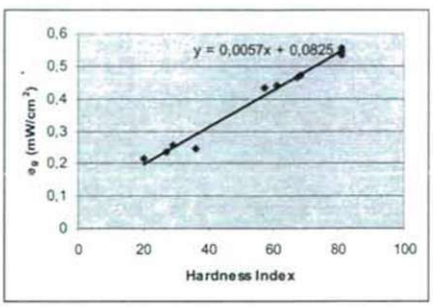

Figure 2. SKCS 4100 hardness index and Perten mill e_g connection

I use twin correlation to determine the relationship among the results. The correlation between the dynamic method (SKCS 4100) and the static tests (Lloyd 1000 R, Instron 5581):

In 2005, the correlations:

- Young's modulus (standing) – Max. breaking force (standing), r=0,838
- Young's modulus (standing) – SKCS 4100 (HI), r=0,720
- Max. breaking force (standing) - SKCS 4100 (HI), r=0,830
- Break work (standing) - SKCS 4100 (HI), r=0,889
- Young's modulus (prone) - SKCS 4100 (HI), r=0,786
- Young's modulus (prone) - Max. breaking force (prone), r=0,659
- Break work (prone) - SKCS 4100 (HI), r=0,722

In 2006, the correlations:

- Young's modulus (standing) – Max. breaking force (standing), r=0,958
- Young's modulus (standing) – SKCS 4100 (HI), r=0,901
- Max. breaking force (standing) - SKCS 4100 (HI), r=0,939
- Break work (standing) - SKCS 4100 (HI), r=0,938
- Young's modulus (prone) - SKCS 4100 (HI), r=0,896
- Young's modulus (prone) - Max. breaking force (prone), r=0,952
- Max. breaking force (prone) - SKCS 4100 (HI), r=0,770

There is a correlation between the dynamics method and the static test.

The Instron has stronger correlation with the dynamic method (SKCS 4100) than the Lloyd test. The static tests help to measure the grain hardness and it can sort the winter wheat in two groups (soft, hard). With this method we have more information about the variety.

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PNEUMATIC POSITIONING SYSTEM CONTROLLED BY ON-OF VALVES

P. Toman[1], J. Gyeviki[2], A. Véha[3], Z. Csizmazia[4]
[1]Alfa Busz Kft, Székesfehérvár, Hungary, mailto:alfabusz@alfabusz.hu
[2]University of Szeged, Szeged, Hungary, gyeviki@mk.u-szeged.hu
[3]University of Szeged, Szeged, Hungary, veha@mk.u-szeged.hu
[4]University of Debrecen, Debrecen, Hungary, csizmazia@agr.unideb.hu

ABSTRACT: *The pneumatic cylinders are widely used in industrial applications for many automation purposes thanks to their advantages. The design of a stable robust position controller for a pneumatic servo-system is difficult. In most cases, applications of pneumatic actuators use servovalves. In the past few years there has been a wide interest in the use of cheap high speed solenoid valves. The main contribution of this paper is instead of using a servovalve, two solenoid valves are applied in the positioning system. The sliding mode controller is implemented on a DSP. The main challenge is the higher accuracy than 10 μm.*

Key Words: *Pneumatic/Positioning/Sliding mode*

1. INTRODUCTION

As an important driver element, the pneumatic cylinder is widely used in industrial applications for many automation purposes thanks to their variety of advantages, such as: simple, clean, low cost, high speed, high power to weight ratio, easy maintenance and inherent compliance. Traditionally, they are used for motion between two hard stop. The design of a stable robust position controller for a pneumatic system is difficult since it is a very nonlinear time-variant controlled plant because of the compressibility of air, the friction force between the piston and the cylinder, air mass flow rate through the servo-valve, etc.

The early applications based on linear PID controllers proposed by Burrows and Web, 1966; Vaughan, 1965 had limited operation area. Fok and Ong, 1999 [1] reached precision of ± 0.3 mm. Fujiwara et al., 1995; Matsukuma et al., 1997 proposed artificial neural network and Jeon et al., 1998 proposed genetic algorithm to tune the PID controller. The precision was ± 0.1 mm in the best case. The best precision (0.01 mm) was reached by Wikander, 1988 [2]. Sliding mode control was proposed by Noritsugu and Wada, 1989; Tang and Walker, 1995 [3]; Surgenor and Vaughan, 1997 [4]; Paul et al., 1994 [5]; Song and Ishida, 1997 [6] but the accuracy was limited.

The pneumatic valve is the key element in the system. There are two types of valves used in the pneumatic positioning, servovalves and on-off valves. With conventional on-off valves accurate position control is difficult to achieve because of the limitation of the valve response time. In the past few years there has been a wide interest in the use of cheap high speed solenoid valves [7]. The most of applications are on pulse with modulation (PWM). By the advent of DSPs with high computation power, the precise and robust control of pneumatic actuators has become possible.

Sliding mode control was introduced in the late 1970's [8] as a control design approach for the control of robotic manipulators. Among experimental studies, a few

succeeded in showing closed-loop system behaviour which was predicted by the theory [9].

Another solution is to employ the advanced nonlinear control strategies developed in recent years (soft computing) [10].

2. DESIGN OF A SLIDING MODE CONTROLLER

In order to design a robust controller and predict the control performance for the pneumatic test rig, a theoretical and practical modelling of the rig is needed. The dynamic of the piston is modelled by the mass "m", the damping "d" and the spring "k". The friction force is denoted by "F_f". The piston can be moved by the pressure difference between the two sides of the piston. The pressures p_a and p_b can be influenced by the input and output air flow rates, which can be controlled by the input and output valves. The system, which can be described by a second ordered nonlinear motion equation:

$$m\ddot{x} = p_a(u)A_a - p_b(u)A_b - d\dot{x} - kx - F_f \tag{1}$$

where x is the position, u is the control signal. The dynamics of the valves are ignored. The other parameters and variables T, V, A, Q and c are the temperature, volume, area, heat energy and specific heat respectively. The subscription refers to the location of actual variable. The calculation of p_a and p_b is based on two main laws, balance of the input, output and inner energies and balance of the input, output and inner masses.

The design of a sliding mode controller consists of three main steps. One is the design of the sliding surface, the second step is the design of the control which holds the system trajectory on the sliding surface, and the third and key step is the chattering-free implementation. The purpose of the switching control law is to force the nonlinear plant's state trajectory to this surface and keep on it. When the plant state trajectory is „above" the surface, a feedback path has one gain and a different gain if the trajectory drops „below" the surface.

Consider a single-input, single-output second-order nonlinear dynamic system:

$$\ddot{x} = f(x, \dot{x}, u) \tag{2}$$

Where x is the output signal (position) of the controlled plant, u is the control signal. If x_d denotes the desired value, then the error between the reference and system states may be defined as $e=x_d - x$.

2.1. Sliding surface design

Classically, a scalar variable s is calculated as a linear combination of the error and its derivative.

$$s = e + \lambda \cdot \dot{e} \tag{3}$$

Let $s(\dot{e}, e) = 0$ define the „sliding surface" in the space of the error state. The purpose of sliding mode control law is to force the state trajectory of the error to approach the sliding surface and then move along the sliding surface to the origin (Fig.1.).

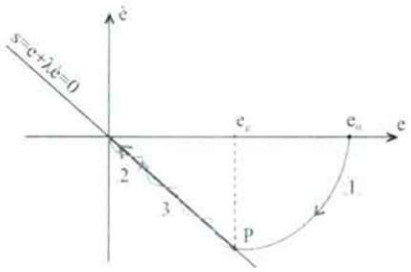

Fig.1. Sliding motion in the state space

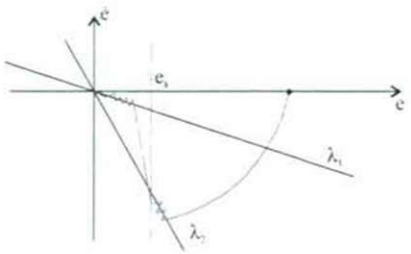

Fig.2. Two sliding lines in the state space

The process of sliding mode control can be divided into two phases, that is, the approaching phase with $s(\dot{e},e) \neq 0$ and the sliding phase with $s(\dot{e},e) = 0$. If the system is in sliding mode the error is decreasing exponentially, where λ is a time constant type parameter. If λ is big than the system response is slow but accurate. If it is small than the system response is fast but the system might chatter (see the experimental results). The proposed solution is the application of two sliding lines (see Fig. 2.).

The steep sliding line described by λ_2 ensures the fast response. When the trajectory get close to the origin, the system change over to switching line of λ_1, to avoid the chattering.

2.2. Selection of the control law

In order to guarantee that the trajectory of the error vector e will translate from approaching phase to sliding phase, the control strategy must satisfy the sliding condition

$$s(\dot{e},e) \cdot \dot{s}(\ddot{e},\dot{e}) < 0 . \tag{4}$$

This means that e will always go toward the sliding surface. A proper control should be selected to satisfy the condition (4) in any time instant. The simplest control law that might lead to sliding mode is the relay. $u = \delta \cdot sign(s)$

2.3. Chattering free implementation

Chattering is the main problem of sliding mode control and chattering free implementation is the key step in design of a sliding mode controller. A quite general solution is that the relay (which changes its output value suddenly) is replaced by a saturation function. There is a boundary layer around the sliding surface where the control signal is changing continuously. If the system trajectory is close to the sliding surface and the control signal is small, than the system might stick before the goal.

To avoid it a modified saturation function shown in Fig. 3. is proposed. When the limitation of the position is satisfied, all high-speed on-off solenoid valves are ON to stop the overshoot. The control will be finished when $|e_s|$ is smaller than e.

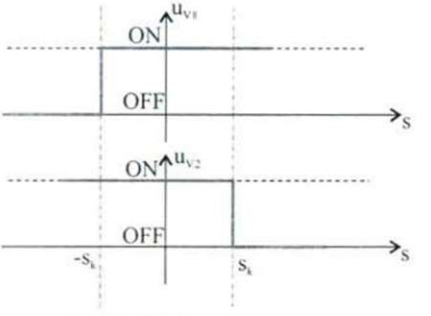

Fig.3. Modified saturation function

3. THE SERVOPNEUMATIC POSITIONING SYSTEM

The system is shown in Fig.4. and Fig.5. It consists of a double-acting pneumatic rodless cylinder (MECMAN 170 type) with bore of 32 mm, and a stroke of 500 mm, controlled by tree-way solenoid valves (Bosch Rexroth 579, FESTO MHE2-MSH-3/2O-QS-4-K fast switching types). A linear encoder (LINIMIK MSA 320 type and BTL5-S101 type Micropulse Linear Transducer with 1 μm resolution from Balluff) gives the position. Velocity and acceleration are obtained by numerical derivation. Pressure sensors (Motorola MPX5999D) are set in each chamber. The controller is implemented in a DSP board of „eZdspTM for TMS320LF2407" from Spectrum Digital.

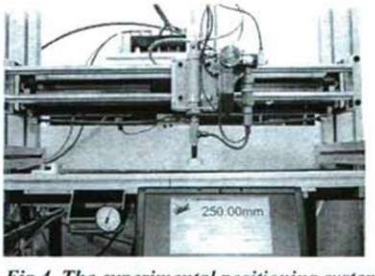

Fig.4. The experimental positioning system

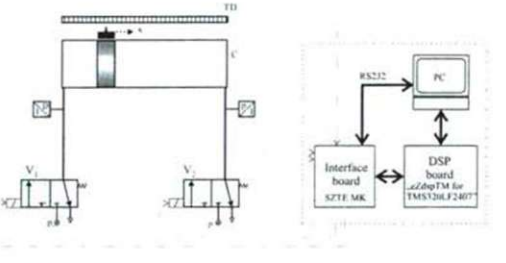

Fig.5. Configuration of pneumatic positioning system

The system pressure is set to be 6 bar, the sampling time is 2 ms. In order to analyze the positioning methods a real-time data acquisition program was designed for a PC to capture the system output data through the communication interface between the PC and the DSP controller.

The control program is in the DSP program memory. So the DSP controller can operate independently. The DSP Starter Kit (DSK) enables the user to connect the DSP to the parallel port on a PC and download code using a DOS interface. The control algorithm is written in "C" language, and compiled into assembly language and downloaded into the DSP board.

4. EXPERIMENTAL RESULT

The conventional (Bosch Rexroth 579), single stage solenoid operated on–off valves are very bulky and their dynamic performances are low. With these valves fine motion control is difficult to achieve because of the limitation of the valve response time. With on-off control the system will never reach a steady state value.

The actual position will tend to oscillate around the desired position. (see in Fig.6. and Fig.7.). The second measurement is a positioning with high-speed on-off solenoid valves. The time functions of the position, speed and control signal is shown Fig.8. and Fig.9. The position error of the DSP based relay type sliding mode control is within ±0.01 mm.

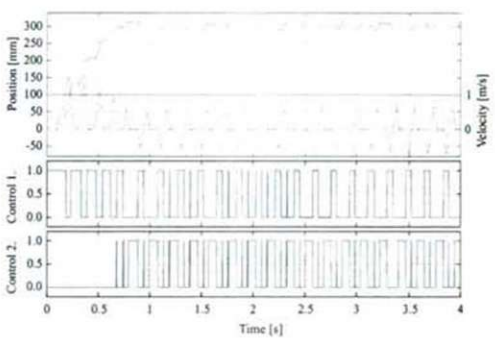

Fig.6. Time functions position and control with conventional on-off valves

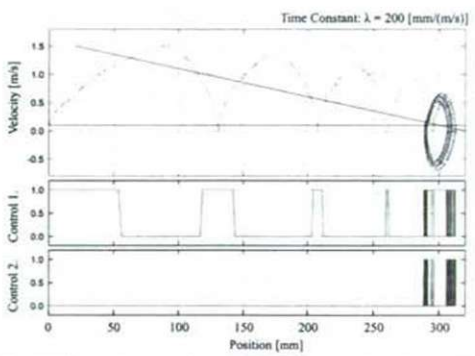

Fig.7. Phase plane trajectory with conventional on-off valves

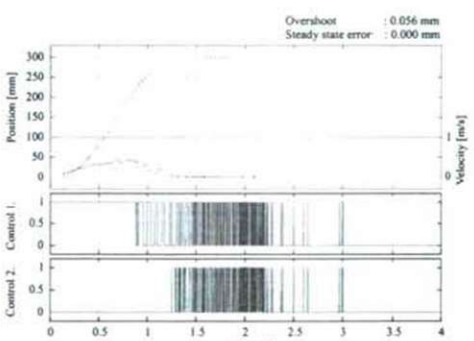

Fig.8. Time functions position and control with fast switching on-off valves

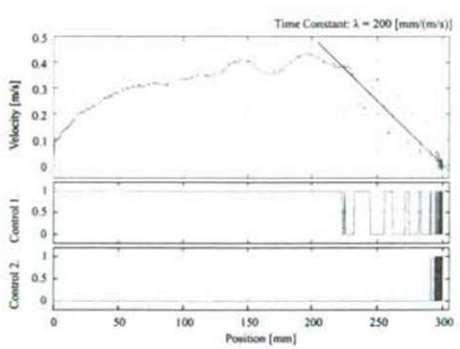

Fig.9. Phase plane trajectory with fast switching on-off valves

5. CONCLUSIONS AND FUTURE WORK

Based on the laboratory measurements we can conclude that the pneumatic servo-systems can be used for precise robust position control, not only movement between two hard stops. The sliding mode control is a promising tool for controlling such systems. The proposed double line and modified saturation function can eliminate the chattering, which is the main problem in case of sliding mode control.

A video can be downloaded from the official web page [11] of International Student Experimental Hands-on Project Competition via Internet on Intelligent Mechatronics and Automation.

Further works we have done with applying the input shaping method. Once the system has reached the setpoint, the residual oscillation will degrade positioning accuracy and may cause a delay in task completion. Input Shaping is a feedforward control technique for reducing vibrations in computer controlled machines. The method works by creating a command signal that cancels its own vibration. That is, vibration caused by the first part of the command signal is canceled by vibration caused by the second part of the command. Input shaping is a command generation technique that is used to reduce command-induced vibration (as opposed to disturbance-induced vibration) [12]. Input shaping is implemented by convolving a sequence of impulses, called an input shaper.

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FLOUR QUALITY AND WHEAT KERNEL HARDNESS CONNECTION

A. Véha, E. Gyimes, B.P. Szabó
University of Szeged, Faculty of Engineering

SUMMARY

Wheat kernel hardness is a very important inheritable parameter; it determines quality, flour yield, flour particle-size, water absorption and other quality characteristics. Besides, kernel hardness has great effect on the resulting flour's baking properties, too (Békési, 2001). The relationship between wheat protein content and kernel texture is usually positive and kernel texture (hardness) influences the grinding energy. Hard Wheat grains require more grinding energy (e_g) than Soft one (Véha, Gyimes 1999).
The aim of our research was to determine the possible relationship between kernel hardness and various other parameters of the flour (dough visco-elastic characteristics, wet gluten, water absorption, flour recovery, alveograph-traits).
We used Perten SKCS 4100 to determine the kernel hardness, while the Perten 3303 mill was used to establish the grinding energy (e_g). Registered and widely used Hungarian wheat varieties (7 of HRWW and 4 of SRWW) were examined. Twin correlations were used to determine the relationship among the various traits. According to the results, there is a very strong correlation between the e_g and the kernel hardness ($r=0.991$). The correlations between hardness index and the examined flour parameters were also significant. We found strong correlation between the e_g and water absorption of the flour. The associations found in this study will help to better understand the technological aspects of wheat and flour quality as well as provide useful information the breeders to develop new, high quality hard or soft wheat varieties.

1. INTRODUCTION

The kernel hardness has great effect on the baking properties of the resulting flour. Flour, which is made from hard wheat generally have a medium to high protein content and stronger gluten than that, which is made from soft one. The Hardness-locus on chromosome 5D is the main determinant of grain texture in bread wheat. Puroindoline-a (pin-a), puroindoline-b (pin-b) and Grain Softness Protein (GSP) genes are tightly linked at this locus and their products are the predominant components of friabilin, a 15 kD endosperm protein complex. The friabilin protein complex determines the kernel hardness. Generally, when the amount of the friabilin is high, the kernel hardness is soft and reverse (Ácsné, 2001). We can sort the kernel hardness in these two groups. Hardness in wheat is largely controlled by genetic factors but it can be affected by the environment, for example the weather (Gyimes, 2004). The transgenic expression of wild type Pin-a sequence in the Pin-a null genotype gave soft grain with the characteristics of soft wheat including stronger starch bound friabilin.

The results of Martin et al (2006) support the hypothesis that both wild type Pin genes need to be present for friabilin and soft grain formation. Vitreousness is also impact to evaluate the Middle-European wheat. The flour of hard wheat with high gluten content generally contains about 12.0-13.0 % (or more) crude protein under Middle-European conditions. The relationship between wheat protein content and kernel texture is usually positive and kernel texture influences the e_g during milling. Hard textured wheat grains require more e_g than those of soft ones. The aim of our research was to determine the relationships between kernel hardness and other technologically important traits in wheat varieties widely used in the Hungarian agriculture (Véha, 2005.)

2. MATERIALS AND METHODS

Eleven samples (registered wheat varieties) of bread with diverse technological qualities were used in this study. The samples were produced in the year of 2006 in Szeged, Hungary and were evaluated for various quality characteristics. Grain samples were taken during harvest (July) and were evaluated after 4 month storage period. The cleaned grain was milled by a Brabender Senior mill to determine the technological tests and establish the flour yield of the samples. Cleaned grain samples were used to identify the hardness index (HI) by SKCS-4100 instrument (Perten Inc.). The SKCS-4100 can complete a test in about 3 minutes, and simultaneously reports mean and standard deviation data for kernel weight, diameter, and moisture content, as well as the HI.

Figure 1. SKCS 4100 instrument (Perten, Inc.)

Grain samples then were ground by Perten 3303 to establish the e_g using 1-phase output indicator interface.

Figure 2. Perten 3303 disc mill (Perten, Inc.)

Moisture content, wet gluten content, farinograph and alveograph tests were determined according to the EU-Standards. Farinograph gave information on the water absorption of the flour. Twin correlations were used to determine the relationship among the various traits, the significant level was 5 %.

3. RESULTS

The moisture, the milling, and other technological traits of the wheat samples, and hardness indexes and grinding energies were showed in Table 1.

Table 1.: Selected parameters of the samples

Class	Entry code	Moisture (%)	Flour yield (%)	Water absorption capacity (ml)	Wet gluten (%)	Alveograph				Hardness Index (HI %)	Grinding energy (mWh/cm^2)
						P (mm)	L (mm)	P/L	W (J)		
SOFT	II.	13.27	71.88	54.8	21.58	42.40	65.50	0.65	102.06	27	0.235
	III.	13.86	71.79	57.3	27.48	63.49	93.75	0.68	204.54	36	0.245
	VI.	14.01	74.01	54.0	16.85	45.72	51.50	0.89	103.99	20	0.215
	IX.	14.00	68.33	56.6	25.30	49.99	67.30	0.75	123.80	29	0.255
HARD	IV.	13.90	72.89	60.9	28.13	88.25	70.00	1.26	251.35	61	0.440
	VII.	13.85	71.28	61.4	22.88	105.50	43.00	2.45	195.84	57	0.435
	VIII.	13.58	70.16	63.2	33.68	87.95	75.50	1.14	226.64	67	0.465
	X.	13.37	70.96	67.9	31.70	93.18	59.90	1.56	178.48	81	0.555
	XI.	13.15	67.94	66.8	35.60	100.30	47.00	2.16	189.91	81	0.545
	XII.	12.82	70.46	63.0	29.68	103.90	61.45	1.69	252.19	81	0.535
	XIII.	12.92	69.66	56.9	31.08	54.85	66.00	0.83	148.09	68	0.470

Table 2.: Correlation matrix for the technological traits and grinding energy of wheat samples

		Hardness Index HI (%)	Grinding energy (mWh/cm^2)	Moisture (%)	Flour yield (%)	Water absorption capacity (ml)	Wet gluten (%)	Alveograph			
								P (mm)	L (mm)	P/L	W (J)
Hardness Index HI (%)		1									
Grinding energy (mWh/cm^2)		0.991	1								
Moisture (%)		0.637	0.600	1							
Flour yield (%)		-0.437	-0.417	0.417	1						
Water absorption capacity (ml)		0.876	0.878	-0.346	-0.402	1					
Wet gluten (%)		0.833	0.781	-0.531	-0.660	0.756	1				
ALVEO.	P (mm)	0.816	0.826	-0.244	-0.224	0.873	0.560	1			
	L (mm)	-0.217	-0.320	0.141	0.096	-0.260	0.171	-0.325	1		
	P/L	0.640	0.687	-0.187	-0.240	0.724	0.300	0.875	-0.691	1	
	W (J)	0.675	0.634	-0.151	-0.055	0.623	0.582	0.808	0.209	0.468	1

The Perten-HI and grinding energy values were showed in Table 1. The SKCS 4100 compartmentalize the results in two groups. Under 50, the samples belong to Soft Wheat-, while samples above values 50 considered as Hard Wheat category. The average HI was 55.2 with minimum of 20 and maximum of 81 values.

According to the results, there was a very strong correlation between the grinding energy and the kernel hardness (r=0.991). As Table 2 shows, the correlations among hardness index and the examined flour parameters were also significant (r=0.816-0.876). We found strong correlation between the e_g and water absorption (r=0.878) of the flour. Hardness index – wet gluten (r=0.833) (Figure 3.), and hardness index – water absorption (r=0.876) (Figure 4.), hardness index – P value of alveograph (r=0.816) showed also positive correlations. We found correlation the water absorption and P value of alveograph (r=0.873).
The associations were found in this study would help to better understand the technological aspects of wheat and flour quality as well as provide useful information to breeders to develop new, high quality hard or soft wheat varieties.

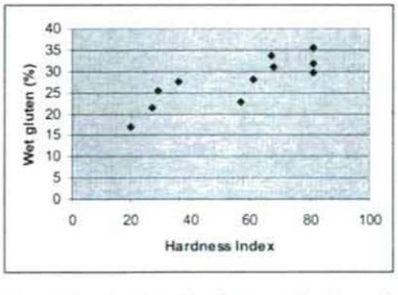

Figure 3.: Relationship between hardness index and wet gluten

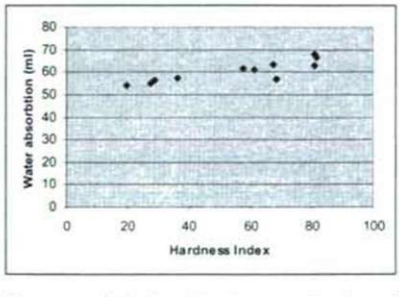

Figure 4.: Relationship between hardness index and water absorption

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INTENSIFICATION OF SEPARATION EFFECTS OF NANOPOROUS POLYMERIC MEMBRANES IN THE GAS SEPARATION PROCESSES

V.M. Vorotyntsev, P.N. Drozdov, I.V. Vorotyntsev, D.N. Shablikin, K.Yu. Smirnov,T.V. Gamajunova

PTMCET department, R.Y. Alekseev Nizhny Novgorod State Technical University, 24, K.Minina str., Nizhny Novgorod, 603950, tel.: (831) 4360361, fax: (831) 4653306, e-mail: vlad@vorotyn.nnov.ru

ABSTRACT

The purpose of the present work is the intensification of the separation effects of nanoporous polymeric membranes in the gas separation processes by the use of the membrane modules with feeding reservoir.

Key words: gas separation, membrane, purification

1. INTRODUCTION

The membrane gas separation is a comparatively new separation process having practical application. It is characterized by low energy and material consumption as well as by relative simplicity of mass transfer apparatus used. There is a possibility of separation process effectiveness change by the change of a type of membrane. On the other hand it is also possible by optimization of apparatus design and organization of gas mixture separation processes.

The purpose of present work is the development of physical-chemical basis of gases high purification with the help of membrane module with feeding reservoir characterized by a new type of separation process organization.

2. THEORY

Membrane module with feeding reservoir is absolutely new type of membrane apparatus. In the membrane module with feeding reservoir the purified gas mixture is placed in the feeding reservoir from where it is actually flown into the membrane module for separation. The impurity component is partially removed while the purified mixture is returned into the feeding reservoir. It allows to carry out the separation and purification of incoming gas mixture repeatedly to the purity level required. After the processes the purified gas stays in a reservoir. That is why the whole process is discontinuous opposing the continuous gas separation used nowadays.

In the lately mentioned method the feed continuously flows into the membrane module while permeate and retentate are continuously isolated from module. The case when the part of permeate and retentate is returned to the feed is called the membrane module with recirculation [1].

The method suggested is based on the statement that selectivity does not depend on the impurity concentration at low level (the same as rectification). In this case the selectivity of the process does not change with time.

Let us analyze the case of low permeable impurity purification processes. The first step is to determine the effective selectivity and the degree of separation of gas mixture component in membrane module. Let's take it for granted that the separation process is carried out in the regime of ideal displacement and counter flow. Impurity concentration here is much smaller than concentration of main component. Moreover the pressure of the cavities of membrane module is constant. The selectivity α does not depend on impurity concentration and more than unity. In case of the low permeable impurity separation it equals:

$$\alpha = \frac{Q_B}{Q_A}, \tag{1}$$

where $\mathbf{Q_B}$ and $\mathbf{Q_A}$ are permeabilities of main components and impurity, respectively.
Let's find the effective selectivity α^* from the mass transfer equation of impurity and main components having run through the elementary part of the membrane [2]. The value α^* is determined as relation of impurity concentration at the membrane surface at any point in the high pressure ($\mathbf{C_1}$, mole fraction) and low pressure($\mathbf{C_2}$, mole fraction) cavities. In case when $\mathbf{C_1}$ and $\mathbf{C_2}$ are much more less than unity it equals:

$$\alpha^* = \frac{C_1}{C_2} = \alpha - \frac{P_2}{P_1}(\alpha - 1), \tag{2}$$

where $\mathbf{P_1}$ and $\mathbf{P_2}$ are pressure of high and low pressure cavities, respectively.
The value of effective selectivity characterizes the separation for the regimes of ideal mixing and counter flow.
Equation (2) shows that effective selectivity does not depend on concentration and stays constant for the whole process of gases high purification in case of low impurity concentration.
The equation of effective selectivity for the high permeable impurity [2] substantially differs from equation (2) and is presented as

$$\alpha^* = \frac{\alpha}{1 + \frac{P_2}{P_1}(\alpha - 1)} \tag{3}$$

which depends on pressure ration of membrane module. In this case selectivity equals

$$\alpha = \frac{Q_A}{Q_B}, \tag{4}$$

The equation (4) is vice versa to equation (1) and more than unity.

From (2) and (3) equation comparison it is evident that for low permeable impurities the dependence of effective selectivity on pressure ration is substantially smaller than for high permeable impurities. It is described by the fact that low permeable impurities are concentrated in high pressure cavity and $\mathbf{P_2}$ change produces less effect on their partial pressure in low pressure cavity and value of α^* than for high permeable impurities. That is why for the separation and purification from low permeable impurities it is possible to use gas compressors with a lower degree of compression.
From mass transfer balance of impurity component at elementary part of the membrane it can be determined the equation for separation factor as ration of impurity concentration in feed and retentate flows.

$$F^{-1} = \frac{C_{1out}}{C_{1in}} = \left(\frac{L_{1in}}{L_{1out}}\right)^{\frac{\alpha^*-1}{\alpha^*}} \qquad (5)$$

where α^* is determined by equation (2) and $\mathbf{C_{1in}}$, $\mathbf{C_{1out}}$ are impurity concentration values of feed and retentate flows, $\mathbf{L_{1in}}$ and $\mathbf{L_{1out}}$ are values of feed and retentate flows.
This equation is similar to Rayleigh equation for the case of separation from low boiling impurity where the effective selectivity (2) is used instead separation coefficient.
In case of separation and purification from high permeable component the equation for the separation factor shown as [3-4]

$$F = \frac{C_{1in}}{C_{1out}} = \left(\frac{L_{1in}}{L_{1out}}\right)^{\alpha^*-1} \qquad (6)$$

From equation (5) and (6) it is evident that in membrane module it is possible to obtain high value of separation factor at comparatively high values of $\mathbf{L_{1in}/L_{1out}}$.
It is necessary to note that in case of change α to $1/\alpha$ in equation (3) and α^* to $1/\alpha^*$ in equation (6) these equation are also similar to Rayleigh distillation equation as (2) and (5).

Let's consider the gases high purification from low permeable impurity with the help of membrane module with feeding reservoir (Fig. 1) [5]. In this case purified mixture follows from feeding reservoir 1 as feed flow into the membrane module 3 at constant pressure. Permeate (more permeable mixture component) returns into feeding reservoir 1 with the help of vacuum-compressor 4. Mixture coming out from apparatus is being enriched by low permeable impurity.
The purification degree of gas mixture in feeding reservoir will be characterized by purification ration **f** which is determined as the impurity concentration relation in the feeding reservoir before $\mathbf{C_0}$ and after **C** purification, $\mathbf{f=C_0/C}$. Let's agree that mixture in a reservoir is mixing intensively enough and impurity concentration is the same at all volume of the reservoir.

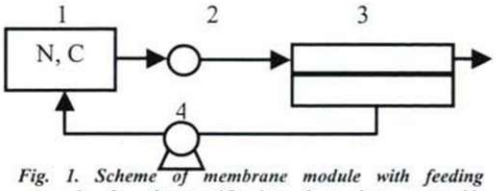

Fig. 1. Scheme of membrane module with feeding reservoir for the purification from low permeable impurities.
1 –feeding reservoir; 2 – pressure reducer; 3 – membrane module; 4 – vacuum compressor.

Also let's agree that the amount of mixture in the membrane module is too small comparing to the amount of mixture in the feeding reservoir. In this case the change of the impurity concentration in the feeding reservoir throughout the purification process will flow analogously to Rayleigh distillation where instead of separation coefficient separation factor F-1 which is found from equation (2) is used.

$$f = \frac{C_0}{C} = \left(\frac{N_0}{N}\right)^{F^{-1}-1} \qquad (7)$$

where N_0, N are the quantities of mole of mixture in the feeding reservoir at the beginning and the end of the purification process, respectively.
Let's consider gases high purification from high permeable impurities with the help of membrane module with feeding reservoir (fig. 2a). In this case purified mixture follows from feeding reservoir 1 through pressure reducer 2 and mixes with permeate flow of the membrane module 3. Than with the help of vacuum-compressor 4 the mixture is sent as feed flow into the membrane module 3 where high permeable impurity permeate through the membrane and purified mixture is coming back to the feeding reservoir 1.
Thus the flow $\mathbf{L_{out}}$ coming out from apparatus is enriched by high permeable impurity and mixture left in apparatus is purified from it. The equation for purification ration is obtained from mass transfer equations for impurity and main components in membrane module and whole apparatus

$$f = \frac{C_0}{C} = \left(\frac{N_0}{N}\right)^{\frac{F-1}{bF+1}} \qquad (8)$$

where coefficient **b** is equal to the relation of retentate and flow coming out from apparatus $\mathbf{b=L_{out}/L_{1out}}$. And **F** is defined by equation (6).
Accordingly it is possible to find the equation for gas mixture purification from high permeable impurities with the help of apparatus with feeding reservoir with additional membrane module (fig. 2b) where the same membrane is used as in the main module. It is acknowledged that the permeate flow

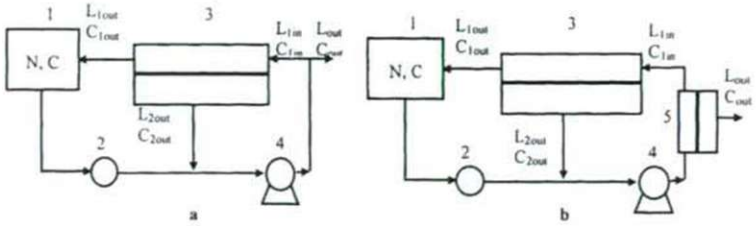

Fig. 2. Scheme of apparatus with feeding reservoir for the purification from high permeable impurities,
a – with one membrane module, b – with additional membrane module 1 –feeding reservoir;
2 – pressure reducer; 3 – membrane module; 4 – vacuum compressor;
5 – additional membrane module.

$\mathbf{L_{out}}$ of additional membrane module is much smaller than retentate flow $\mathbf{L_{1in}}$ of this module which is a feed flow for the main membrane module. That is why additional membrane module works in a regime of ideal mixing. For this additional module there is a condition $\mathbf{C_{out}/C_{1in}}$ equals to $\alpha^*.\alpha^*$ is found from equation (3).

And the pressure of the cavities of additional module is the same as in the main module. In this case the equation for purification ration is found as

$$f = \frac{C_0}{C} = \left(\frac{N_0}{N}\right)^{\frac{\alpha^* F - 1}{\alpha^* bF + 1}} \qquad (9)$$

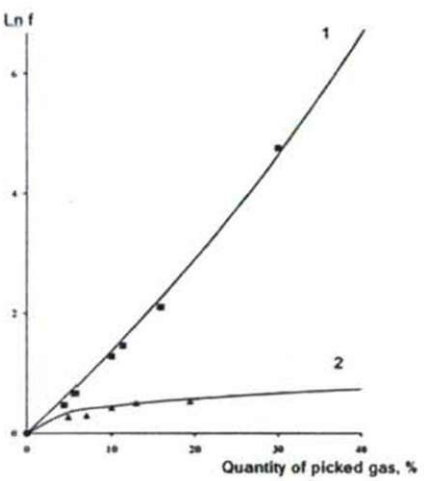

Fig 3. The dependence of purification ratio from quantity of picked substances for mixture CCl_2F_2 – impurity of C_3F_8
1 – membrane module with a feeding reservoir (F-1 = 14);
2 – single membrane module
Δ, □ - experimental data

3. RESULT AND DISCUSSION

For the estimation of the separation power of this apparatus diclorodifluoromethane (CCl_2F_2) high purification from perfluoropropane C_3F_8 was considered. The ideal selectivity for this system CCl_2F_2 - C_3F_8 is equal to 2.94. As the membrane Silar® (the membrane on the base of polydimethylsiloxane) was used. It was shown (figure 3) that application of membrane module with feeding reservoir allows purifying main component from low permeable impurities at low product loss.
The comparison with single module is carried out also. It was shown that new apparatus with feeding reservoir more effective than single membrane module (figure 3). The degree of separation is increased with the help of multistage returning of gas mixture and constant selection of impurity from the feeding reservoir.

4. CONCLUSION

In conclusion we can say that such new apparatus might be of interest for gases and vapor purification from low penetrating impurities and also for high penetrating impurities.

Acknowledgements
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Symbols
α - selectivity
Q – permeability, (mole·m)/(m^2·s·Pa)
α^* - effective selectivity
C – concentration, mole fraction
P – pressure, Pa
F – separation factor,
L – flow, mole/s
f – purification degree
N – quantities of mixture in the feeding reservoir, mole
b – coefficient

Indexes
A - impurity
B – main component
1 – high pressure cavity
2 – low pressure cavity
in – input to the cavity of the membrane module
out – output from the cavity of the membrane module
0 – initial value, before the purification process

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"CONVEX POLYHEDRON FEATURES AND THEIR UNFOLDING TO A CONNECTED NON-OVERLAPPING POLYGON" (PREPARING A CREATIVE PROVE OF THE DÜRER'S CONJECTURE)

Tamás Endrődy
University of Szeged, Faculty of Engineering

1. INTRODUCTION

Albrecht Dürer published around 1525 his conjecture: "All the polyhedrons can be unfolded by their suitable cutting edges to a plane so that we can receive a joined polygon-mesh with non-overlapping faces" [Dürer, 1]. The author of this article is dealing basically with the suitable positioning of cutting edges for unfolding the polyhedrons (to a plane), coding the polygon received and its modelling surface. His aim is to give tools for proving the Dürer's conjecture and/or to prepare a creative prove. The notion of the **finite convex polyhedrons** has a very large set of solids from tetrahedrons to the arbitrarily complicated polyhedrons —covered by **p≥3 s**ided convex polygons— which have 1ess and less or nil symmetrics. In the case of the **analysed finite convex polyhedrons** 2 polygons meet in each edge, in their peak **q≥3** pieces of polygons meet where the angle is **alfa** $_{Pi}$**<360°** in consequence of convexity, otherwise it can be degraded to a plane and can become infinitely big, which was formerly excluded. The **spherical mosaic** ordered to the polyhedron can help us many times, which can be gained by **the projected polyhedron-peaks from an internal point to of an external sphere surface** which has only **mutual points (min2) with the polyhedron**.

They have many similar topological and geometrical properties, so the spherical mosaic **can help unfolding the facets** of the polyhedron and **defining the structure** of the unfolded polygon-mesh in a plane. The **spherical mosaic/globe notation system** is very useful:

- in the exposition of the performable operation on the polyhedron-surface in surface modelling,
- in marking out **cutting edges** of their polygons **marching via the "0 longitudinal circle"** and
- in the **joined polygon-chains: e.g.** (first of all) **via the "Equatorial (parallel) Circle"**. We can mention besides the **North (N) and South (S) Poles**, the E_W starting point on the **Equatorial (E) Circle** and on the **"0 Longitudinal Circle"** walking round on the **E circle** from West to East to the arrival point E_E, which is identical with E_W ($E_E \equiv E_W$).

We would like to use also the notion of the **"Condensation-Points" (CP_i) on the Northern and Southern Hemispheres,** the **North (N) and South (S) Pole,** in which peaks

q_N**>>3** and q_S **>>3** pieces of polygons run together, but in both of Hemispheres can be further "Condensation-points".

Naturally every globe point- (**N, S,** E_W, E_E, ...) notation can be used to the effect that every named globe point means **the nearest polyhedron-peak** (nodepoint). In the same way we mean by the **"Equatorial (E) Circle"** and **"Longitudinal Circles"** the **continuous zigzag edge-chains of the polyhedron, which are nearest to a circle** being discussed.

2. MODELLING CONVEX POLYHEDRONS BY BREP- AND WINGED EDGES-STRUCTURES

The Boundary REPresentation faces **(BREP)** modelling system was developed originally **for surface modelling** aim. But soon it was proved that BREP could be an efficient tool **for solid modelling too,** if a 3D region of the space is closed by boundary faces without holes, consequently a piece of the body is circumscribed by them. The **BREP** as a solid modeller **is an "object's present state"** describing system in 3D **by surface elements** in particular **by polygons** covering a polyhedron **or by free-form patches** covering a solid body or anyway a piece of the body **(Figure 1)**.

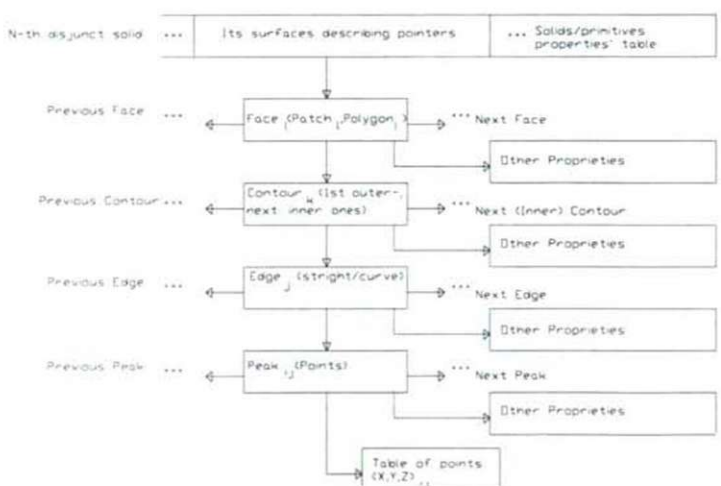

Figure 1 The main structure of the BREP surface model

In the BREP model all information is available in the traffic on the surface of a solid body connected with the neigbouring faces, their boundary contours, edges and peaks.

On the other hand, the **original solid modelling system CSG** —Constructive Solid Geometry— is a **"generative system"**, in this case using a **"historical method"** to describe a solid body from an initial state, via many stadia, up to the final state of the body [Braid, 3]. The tools for the solid-model modifying are **the Euler operators: OP {p, e, f, r, s, h}**, where **p**=peaks/vertricies, **e**=edges, **f**=faces, **r**=rings, **s**=shells, **h**=holes have the number of components. Every disjunct manifold solid, being in the real world, has the following topological condition: **p–e+ f–r=2*(s-h)** **(1^{st})**, which is the **Euler-Poincaré term**. In the case of the convex polyhedrons **Euler-Poincaré formula is** simplified as follows:

$$P - E - F = 2 \quad \ldots (2^{nd}).$$

After using the solid model modifying operations the consistency of the body remains valid [Mäntylä, 7]. In practice we usually do not like to use the Euler operators, we should rather prefer to use the **BREP system operators** for manipulating the pieces of the surface-elements: extruding, rotating, wresting moving, unfolding and gluing the surface/solid elements, or the **generative CSG system operators** for the solid-Boole-algebraic operations: union, product and substract, etc.

In the early seventies the 3D geometrical modelling **systems had only polyhedron-modelling operations** such as describing, modifying polyhedral surfaces or solids, still in the cases of conic, cylindric and other curvilinear bodies, too. It was easier to start with modelling the surfaces or the bodies by the system which can only allow to describe and manipulate the boundaring by planes or the facetting bodies [see: M., Sabin, 2; I.,Braid, 3; M., Brun, 4]. This method could ensure many advantages when modelling rather complicated surfaces or bodies, too, like the hull of a ship-body, surface elements of a car-body or of an airplane-wing and designing these, and e.g. describing/modelling the surfaces and the movement of a very complicated airplane-landing ship. It offered many advantages when formerly using the polyhedral bodies and surfaces with quite a modest computer-throughput. **Most of the mechanical tasks can also be fulfilled by modelling the surfaces of the polyhedral bodies**: like designing parts-, tools-, envelop-surfaces, statical-, dynamical- and stress-analysing. **These facts drew the author's attention** to the polyhedral modelling and **unfolding the polyhedrons' surface.**

The BREP model became a really effective tool, when Baumgart published the **Winged edge modelling structure [Baumgart, 5]:** Node substructures. Each type of Node had a pointer-chain, and each edge, i.e. each ENOD has two wings: one "-FNOD" and one "+ FNOD", because each edge has two half-edges, both of which have one face, as a"wing".

Figure 4 shows the original Winged edge modelling structure, but for each node only the first few lines belong to it. We can use BREP model more effectively also as a solid modelling system because of its present state and locally object describing characteristic: surely in designing-, modifying- and describing tasks, one can be engaged more effectively with all of the little details, and it is not necessary to deal with or to modelize permanently the whole of the very big object in every case (see contrast with the CSG solid model, because of its global and generative characters). The surface-modelling properties of BREP became really better in the "BREP extended by Winged edge modelling structure", where we can determine the important properties of each point, e.g. on what face(s) is it,

- what kind of contour(s) are around every point also in the multiple contiguous surfaces,
- which are the characteristic-, boundary-, and mutual interfusing lines nearest to the actual point and
- which kind of peaks are crossed by the contour of each surface.
- we can determine in the case of a closed surface/body in what direction is the interior of the object,

in what direction is the normal vector pointed and where is the attendant trihedron (vectors).

The author augmented the original Winged edge modelling structure with many details to make it suitable for his special aims: for unfolding the surface of polyhedrons (see Figure 4). In BREP by the enlarged Winged edge model we can use each polyhedron edge as a "winged edge".

3. SOME PROPERTIES OF THE CONVEX POLYHEDRONS AND SEARCHING A SUITABLE EDGE-CUTTING STRATEGY

3.1 The homology of the convex polyhedrons and the spherical mosaics

There are some spherical mosaics simplier than the tetrahedron that can be produced via Euler operators beginning with the case of "Sphere and a point on it" where **the 2nd formula is fulfilled (P=1, E=0, F=1)**. Via these Euler operators we can produce the simplest polyhedron, i.e. the tetrahedron (by its peaks) — to which a spherical mosaic can be ordered and vice-versa, thus they have a kind of homology. The BREP surface and solid modelling systems are using these properties, which are based on Euler operators [M. Mäntilä, 7].

This publication is dealing with a narrower set: with the convex polyhedrons. Naurally we can also declare that, it isn't possible to order any spherical mosaics to a convex polyhedron in a mutually unambiguous way, because each spherical mosaic can be projected to concave polyhedrons, too.

3.2. The form-features of convex polyhedrons

We can classify the convex polyhedrons according to their form-features they can have

bar, sheet and **body characteristics**:

- a convex polyhedron has a **bar** character/nature at which the extent in **Z** direction is
  considerably bigger than in the direction **X** and **Y**: $\Delta Z >> \Delta X, \Delta Y$;
- one has a **sheet** character/nature at which the extent in **Z** direction is considerably less than
  in the direction **X** and **Y**: $\Delta Z << \Delta X, \Delta Y$;
- one has a **body** character/nature at which the extent in **X,Y** and **Z** direction is essentially
  the same: $\Delta Z \approx \Delta X \approx \Delta Y$;

Naturally we can define other form-features for convex polyhedrons on the base of extent in **X,Y** and **Z** directions.

3.3. Condensation-points and the successful edge cutting strategy

The convex polyhedrons and spherical mosaics can be classified also by their Condensation-points:

- the convex polyhedron can have $\mathbf{Cp_i=1}$ piece of Condensation-point, e.g. in the case of pyramidical or drop-shaped cut precious stone, when the **N (North) Pole** suits to that, where $\mathbf{q_N>>3}$ is and on the other end a **p** sided polygon closes the convex polyhedron. In this case unfolding the convex polyhedron we can get a joined polygon, which can have a **single running down star character form** (**Figure 2** and **3/a**) but it is possible unfolding this polyhedron to several other non-overlapping character forms, too. However, one may suitably indicate every time **the first cutting zigzag edge-chain on the "0 Longitudinal Circle"**;

- but the convex polyhedron can have $\mathbf{Cp_i \geq 2}$ pieces of Condensation-points and also of the spherical mosaics ordered to it (**Figure 2 and 3/b).** Using the spherical mosaics/globe notation **the two Condensation-Points ($\mathbf{CP_N}$,$\mathbf{CP_S}$) on the Northern and Southern Hemispheres** are the **North (N) and South (S) Pole,** where $\mathbf{q_N>>3}$ and $\mathbf{q_S>>3}$. Further Condensation-Points ($\mathbf{CP_i}$, $\mathbf{CP_j}$) can be on the Northern and Southern Hemispheres, these can be stringed to the first cutting zigzag ($\mathbf{CP_i}$-**N-**$\mathbf{E_W}$-**S-**$\mathbf{CP_j}$) edge-chain. In this classification 2 pieces of **CPi-s** are the most characteristic .

The author developed an algorithm of indicating and performing cutting edges **for unfolding the convex polyhedron-surface** to have one joined non-overlapping polygon in a plan.

a) **Before performing** each cutting-edge chain**, one must indicate** all of the edges:

- first we indicate one circle on the spherical mosaics/globe by its two endpoints,
- than we seek for each nearest peak-point of polyhedron to these two endpoints,
- one indicate all of the nearest peaks of polyhedron to this indicated circle on the spherical mosaics/globe, as a zigzag (cutting) edge-chain (Figure 5).

b) We have to indicate and to **perform "1 rowed joined polygon-chains"**,too. Before performing it each operation begins also with the indication, so indicating the joined polygon-chain as follows:

- first we can indicate one circle on the spherical mosaics/globe by its two endpoints, **by the beginning point** (e.g. first by E_W **being on the "Equatorial Circle" and on the "0 Longitudinal Circle"**) and walking round on the actual circle- **by the endpoint** (with first example on **E Circle West to East** by the endpoint $E_E \equiv E_W$), then

- follows indicating the **1 rowed polygon-chain nearest to the actual circle** (first nearest to the **E Circle**), which will also surround the actual circle in a zigzag line

Note: Only when we have indicated all of the 1 rowed polygon-chains, and **we have indicated all the polygons of the polyhedron completely, that time we could perform** the cutting edge-chains and the joined polygon-chains.

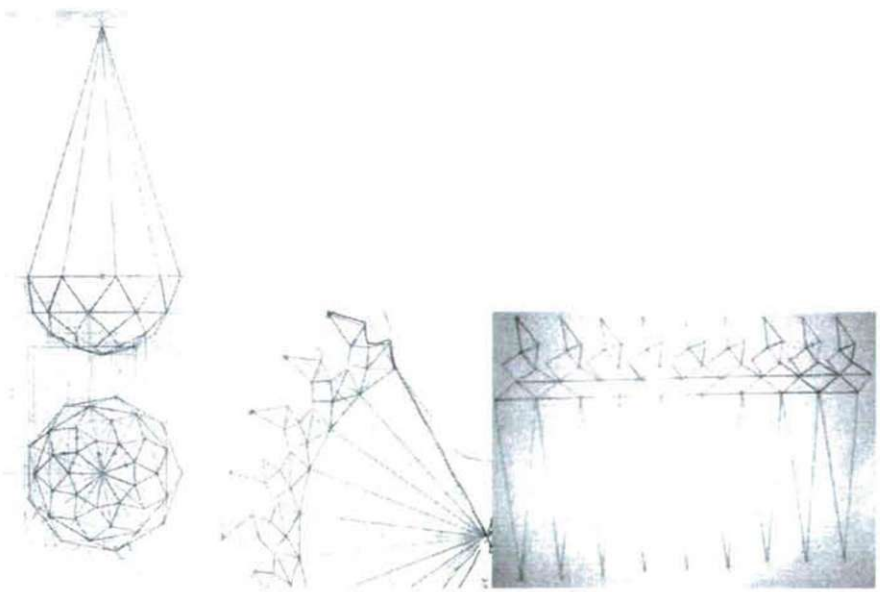

Figure 2 Unfolding the convex polyhedrons having some symmetries we can choose the algorithms which are suitable to the 1 and 2 CPi-s too (Figure 3/a and 3/b), for gainingthe joined non-overlapping polygon-meshes

The major steps are the following:

I)- we will indicate and perform **the first cutting zigzag edge-chain** on the **"0 Longitudinal Circle":** this will be the **S – E_w – N** zigzag cutting line, **with which we will open the closed surface covered by the polyhedron-body. Thus its surface becomes a closed two-dimensional (2D) surface in the space bordering by the cutted half-edges S – E_w – N — N– E_w– S, it becomes a closed, 2D surface in 3D completely filled by polygons;**

II)- indicating and **performing the first**, most important 1 rowed, **joined polygon-chain on the "Equatorial Circle",** which consists of **m pieces of polygons;**

III)- then we can indicate and **perform the essential star-branches** from the polygon-edges of the joined polygon-chain **from the E**quatorial (**E**) **Circle** to the **North** and **South CPi. These essential star-branches** can have **max. n** pieces of polygons in the directions to the **N** or the **S CPi** (Figure 5).

From the edges of the **E**quatorial (**E**) joining **p>>3** sided polygons **max. p essential star-branches can branch off,** but generally **max.(p-2)** pieces can be started to the **N** and **S CPi-s** because 1-1 piece of engaged edges joins together polygon-pairs (**–FNOD** and **+FNOD**);

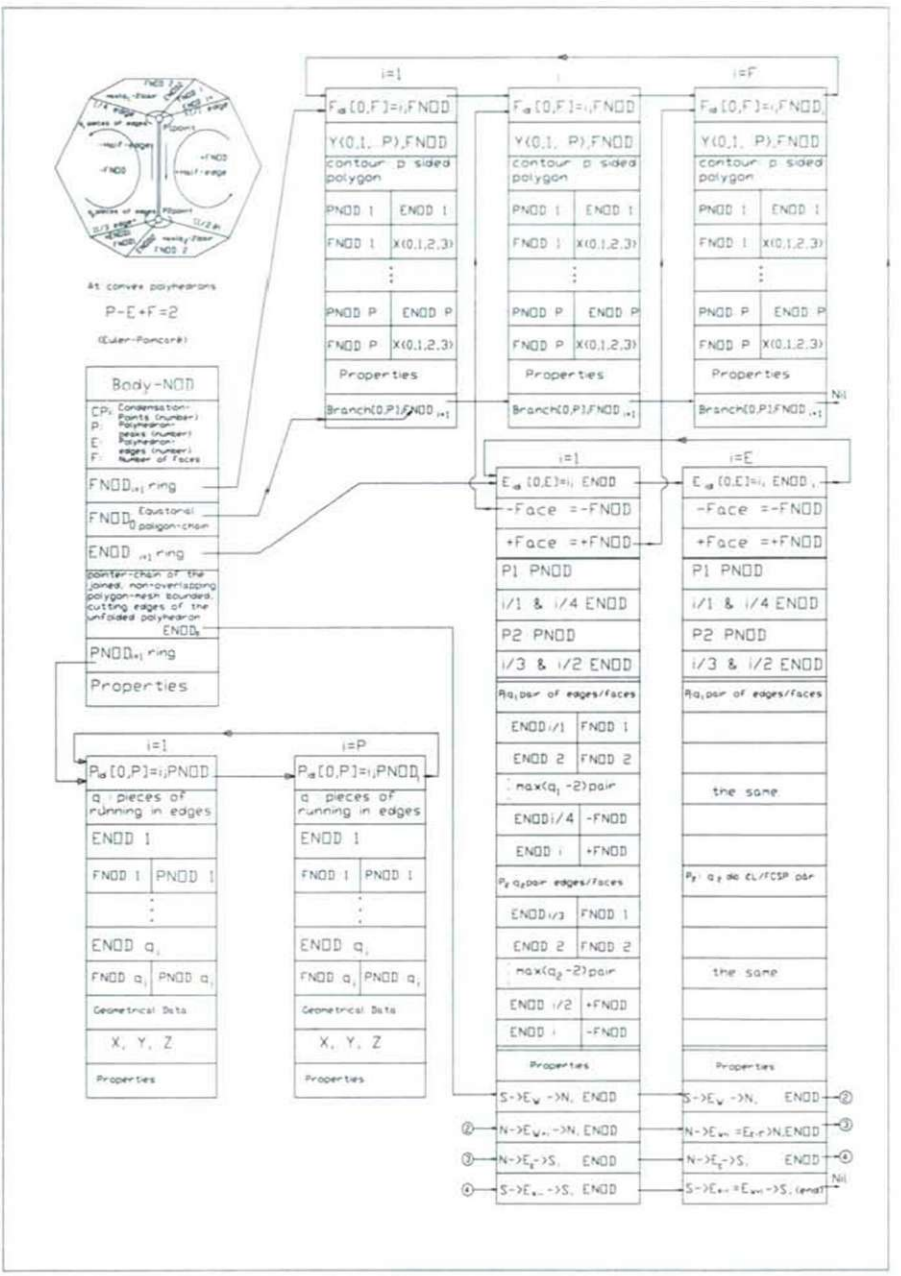

Figure 4 Augmented structure of the "Winged edge model" for unfolding the convex polyhedrons

- these **max. m** of **essential star-branches** start from the **E polygon-chain** to the **N** and **S CPi-s**, but they can die off on the way, and new essential star-branches can be born because of the recursive branching out of themselves. Thus not definitely the same number of **essential star-branches** march into the **CPi-s** as many of them could start from the **E polygon-chain**;

- vica versa, from the **N** and **S CPi-s** q_N **pieces** ($q_N >> 3$) hence **not m** pieces of **cutting edges** start to the polygons of the **E** polygon-chain, but the same number of $q_N >> 3$ **and** $q_S >> 3$ **pieces of polygons running into the N** and **S CPi-s**, that is q_N pieces of essential star-branches/1 rowed, joined **polygon-chain start to the "Equatorial (E) Circle".**

IV)- after indicating the essential star-branches **we must indicate all the recursive branching out of themselves** to less star-branches, up to where they could reach – marching from **W**est to **E**ast- the border of the next essential star-branch or of any other star-branch.

Surely all of the star-branches are 1 rowed and they **couldn't cut** -only can touch- another polygon of another **neighbouring star-branch**.

Notes: The essential star-branches are **indicated by the "Longitudinal Circles"** running from the **N**orth and **S**outh **CPi-s** to the forthcoming polygon-peaks of the **E**quatorial **(E) Circle** joined polygon-chain. These **"Longitudinal Circles", in fact** the **continuous zigzag edge-chains of the polyhedron, which are nearest to these circles,— make regions for the essential star-branches and the recursive branching out star-branches**.

We can observe that **all the peaks of the polyhedron have min. 1 cutting edge** — in this cutting edges strategies proposed (see the double lines, namely half-edges in Figure 5).

Affirmation (1): By this strategy for cutting out the edges **"one can always be able unfolding the convex polyhedron-surfaces to a star-shaped, one-rowed joined polygon-chain"**, which has a general **tree structure** with **n** levels and **m** branches (Figure 5).

4. AUGMENTED STRUCTURE OF THE "WINGED EDGE MODEL" FOR UNFOLDING THE CONVEX POLYHEDRONS

We can unfold the surface of each convex polyhedron to a **star-shaped tree structure formed from joined polygon-chains suitably for Affirmation (1), but it is a much more modest affirmation, than the Dürer's conjecture was made about 1525.**

He stated: **"all the convex polyhedron-surface can be unfolded without exception —to a joined non-overlapping polygons— by cutting their suitable edges"** [Dürer, 1].

This conjecture was proved by O'Rourke at al. about 1992 [O'Rourke, 8] -and in the information/knowledge of the present author- via a creative mood. O'Rourke was the first who asserted that it is possible, namely to a joined non-overlapping polygon, suitably for the condensation points following manifold running down,- to a complex star-shaped polygon.

The **"Winged edge model"** with some **augmented structure is** effectively suitable —according to the author— not only for modelling the convex polyhedron body and surface as well as marching on its surface, but for also **the following operations** (Figure 4):

- for unfolding the polyhedron-surfaces, namely indicating-, after performing the cutting edges,
- tracing and debugging the performing process, moreover
- describing and coding the unfolded polyhedron-surface to a mesh of convex polygons which can be the above mentioned 1 rowed joined, star-shaped, non-overlapping or overlapping a concave polygon.

Thus the **winged edge can be an excellent tool for the proof** of the non-overlapping character. The enlarged winged edge structure contains Point NODe (PNOD)-, FaceNODe (FNOD) EdgeNODe (ENOD) substructures, and among those Body NODe Body-NOD gives relation.

Some data in the **augmented winged edge for FNOD** about the Faces **of the convex polyhedron:**

2nd data: Y{0,1,...P} gives the characteristic of **i th actual polygon/Face**-state, where its meaning is:

Y{0,1,...P}=0 if not one single **(0)** side of the **i th** actual polygon are prepared that is we don't know anything about edges of the i th actual polygon then its edges are cutting or joining/winged edges;

Y{0,1,... P}=j, (max. P) if **j pieces of edges are already prepared** partially or wholly (see the state of edge describing **X{0,1,2,3}** state-characteristic, the **5th** data of the actual (**i th**) Node;

5th data: to all the **P pieces of edges** of the **i th** actual polygon belonging to **4-4 data**, there are:

a) the starting **point/PNOD** pointer of the **actual k[1,P] th edge** ;

b) the **ENOD** pointer of the **actual k th edge**;

c) neighbouring **polygon's FNOD** pointer **being on the other side** of the **actual k th edge**

d) the state characteristic X{0,1,2,3}of the **actual k th edge, which means:**

X{0,1,2,3}=0, if **actual k th edge** hasn't been yet analysed **in view of cutting** and not in having a role as a winged edge **joining the polygons,** thus we haven't analysed in the process of unfolding to a plane;

X{0,1,2,3}=1 or 2, if the **actual k th** edge is a **cutting edge** and **X{0,1,2,3}=1**, if this **actual edge could have a role only ones** in the process of **marching around the unfolded, joined polygon-mesh**, and **X{0,1,2,3}=2**, if on the **actual k th** edge we marched already forwards and backwards, too.

X{0,1,2,3}=3, if the **actual k th** edge is **winged edge**, thus the to neighbouring, joining faces on the

(**–FNOD** and **+FNOD** at Figure 5) **will be already indicated for joining.** This state generally can rise only after the whole unfolding process to the plane,- for all of the edges.

7th data: Branch[0,P] gives it how many sides of the **actual k th** edge give branches for starting element of the 1 rowed joining polygon-chains: (for the **Equatorial** joining polygon-chains, for the **essential star branches or for** the recursive branching **star-branches**)

8th data: it is the **next FNOD** pointer of the Equatorial joining polygon-chain in the direction E_W->E_E

Notes: All the other 1 rowed joined polygon-chains are coded by the **FNOD** beads **on the base of the state characteristics** and **of the pointers** of the **P** sided polygons. In this way the unfolded joined polygon-mesh can be projected very effectively from the polyhedron-surface, which will form a generally **n level in (m or p) branching tree structure**

Some data in the augmented winged edge structure **for ENOD** (Edges) **of the convex polyhedron:**

4th data: the actual **i th winged edge** boundered by **P1** and **P2 has q_1 and q_2** pairs of **ENOD/FNOD** pointers, which are coded in the CCW direction on the structure (Figure 4).

6th data: via the tools of the suitably cutting edges —unfolding the convex polyhedron-surfaces— got a **joined star-shaped polygon-mesh** consisting of **one rowed-polygon-chains. We could describe by pointer-chains the marching process around this concave polygon.** The sections of this pointer chain can be found at the end of the **ENOD** substructure.

5. THE WINGED EDGE IS THE TOOL FOR PROVING THE NON-OVERLAPPING BY COMPLETE INDUCTION

This chapter gives a proof for the non-overlapping polygon-mesh. The convex polyhedron's **surface cut near to "0 Longitudinal Circles"** can be decomposed to one rowed polygon-chains.

AFFIRMATION: The surface of the convex polygon can be unfolded to a **joined non-overlapped** polygon-mesh, **if marching through** all the polygon-chains **by a "piece of surface"** in the **i=1,2,…,m/n** cases with suitable cutting edges (Figure 5). It is provable, that the polygons of each **"piece of surface"** of all the polygon-chains— will move off from each other and move off from the earlier unfolded polygons, too. **The "piece of surface" is "the winged edges" joined polygons.**

All the peaks have one or more cutting edges at the proposed cutting edge-algorithm.

The bigger steps of proving the NON-OVERLAPPING is the following:

I) it was already indicated by the **beginning cutting edge-chain,** a closed 2D zigzag line in the space **from half–edges (S – E_w – N — N– E_w– S)**, which **opened the polyhedron's space-portion** and transformed its surface **into a closed 3D surface** completely filled by polygons;

II) then was indicated the **E**quatorial **(E) joined one-rowed polygon-chain**, so with that the steps will be introduced in details **i=1,2,…,(m-1),m** of the proof **with complete induction;**

III) later had to be indicated all of the **"essential star-branches"** branching off the **E polygon-chain,** which were marching from West to East: E_W -> $E_E \equiv E_W$ **(i=1,2,…,m).** At all of the **"essential star-branches"** we must apply **the proof with complete induction** from the **N**orth and **S**outh **Pole/CPi** backwards in the steps **j,k=n,(n-1),…,2,1** up to the **E Circle** or up to the **borders** of the next **"essential star branch"**/recursive **star-branch.** This proof with complete induction can be introduced **in II) case** may apply also to this **III) case** but with opposite direction.

IV) finally at each polygon-chain of all the **star-branches recursively** branching off the "essential star-branches", ought to be applied the **"proof with complete induction"**, always from the dying off peak-point to the arrival point of the higher level **"star-branches" or** upto the **E Circle.** Otherwise it is **sufficient thinking over recursively this proving process.**

II) The proof *with complete induction* of affirmation concerning the E joined polygon-chain

1st step: The "$P1^{i=1}$–$P2^{i=1}$" edge is joining together (Figure 5) the i=1st polygon to the i=2nd polygon.

a) At the $P1^{i=1}$ peak of the convex polyhedron: **originally** there is **no edge cut,** so the polygons marching into this peak have the angle (sum of their plane-angle): **$alfa_{P1}^{i=1}$ <360°;** if at the unfolding process **one edge of $P1^{i=1}$ is indicating to cut,** this angle will be **$alfa_{P1}^{i=1}$ =360°.** So **the i=1st (actual) "essential star branch" bordered $P1^{i=1}\equiv P2^{j=1}$** polyhedron peak and the $P2^{j=2}$ (i=1) peak joining actual "essential star branch" having $P2^{j=1}$–$P2^{j=2}$ will be opened. So it will be cut to half-edges, then the **i= 2nd "essential star branch's"actual polygon** will move off the **i= 1st "essential star branch's"actual j=2 polygon.**

b) At the $P2^{i=1}$ peak of the convex polyhedron: **originally** there is also **no edge cut,** so the polygons marching into this peak have the angle (sum of their plane-angle): **$alfa_{P2}^{i=1}$ <360°;** if at the unfolding process **one edge of $P2^{i=1}$ is indicating to cut,** this angle will be **$alfa_{P2}^{i=1}$ =360°.** So each polygons marching into the $P2^{i=2}$ can be unfolded and will move off the polygon being in the cutting edge's other endpoint being the **k= 2nd** polygon of the **i= 2nd "essential star branch".** Thus we can state, that the joining edge between the **i= 1st and i= 2nd** polygons, the **$P1^{i=1}$–$P2^{i=1}$ winged edge has** both of two endpoints **cutting edge**, this way **the polygons** —earlier touched one another— being in **$P1^{i=1}$ and $P2^{i=1}$ will move off each other.**

2nd step: The "$P1^{i=2}$–$P2^{i=2}$" edge is joining together(Figure 5) the i=2nd polygon to the i=3rd polygon.

a) At the $P1^{i=2}$ peak of the convex polyhedron: **originally** there is **no edge cut,** so the polygons marching into this peak have the angle (sum of their plane-angle): **$alfa_{P1}^{i=2}$ <360°;** if at the unfolding process **one edge of $P1^{i=2}$ is indicating to cut,** this angle will be **$alfa_{P1}^{i=2}$ =360°.** So **the i=2nd (actual) "essential star branch" bordered $P1^{i=2}\equiv P2^{j=1}$** polyhedron peak and the $P2^{j=2}$ (i=2) peak joining actual "essential star branch" having $P2^{j=1}$– $P2^{j=2}$ will be opened. Thus it will be cut to half-edges, then the **i= 3rd "essential star branch's"actual polygon** will move off the **i= 2nd "essential star branch's"actual j=2nd polygon.**

b) At the $P2^{i=2}$ peak of the convex polyhedron: **originally** there is also **no edge cut,** so the polygons marching into this peak have the angle (sum of their plane-angle): **$alfa_{P2}^{i=2}$ <360°;** if at the unfolding process **one edge of $P2^{i=2}$ is indicating to cut,** this angle will be **$alfa_{P2}^{i=2}$ =360°.** So each polygons marching into the $P2^{i=2}$ can be unfolded and will move off the polygon being in the cutting edge's other endpoint being the **k= 3rd** polygon of the **i= 3rd "essential star branch".** Thus we can state, that the joining edge between the **i= 2nd and i= 3rd** polygons, the **$P1^{i=2}$–$P2^{i=2}$ winged edge has** both of two endpoints **cutting edge**, this way **the polygons** —earlier touched one another— being in **$P1^{i=2}$ and $P2^{i=2}$ will move off each other.**

3rd step: The "P1$^{i=(m-1)}$–P2$^{i=m}$" edge is joining together the i=(m-1)st polygon to the i=mth polygon.

a) At the **P1$^{i=(m-1)}$** peak of the convex polyhedron**: originally** there is **no edge cut,** so the polygons marching into this peak have the angle (sum of their plane-angle): **alfa$_{P1}{}^{i=(m-1)}$<360°;** if at the unfolding process **one edge of P1$^{i=(m-1)}$ is indicating to cut,** this angle will be **alfa$_{P1}{}^{i=(m-1)}$=360°.**

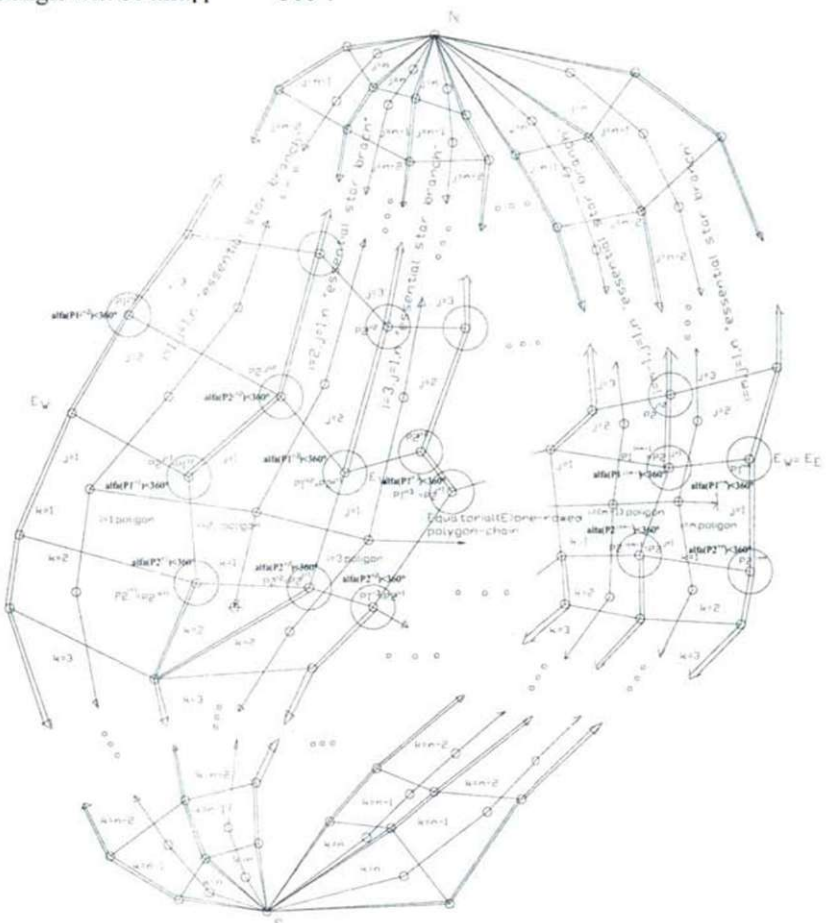

Figure 5 The Application of the Winged Edges Model

Thus the **i=(m-1)st actual "essential star branch" bordered** $P1^{i=(m-1)} \equiv P2^{j=1}$ polyhedron peak and the $P2^{j=2}$ (i=m-1) peak joining actual "essential star branch" having $\underline{P2^{j=1}-P2^{j=2}}$ will be opened. Thus will be cut to half-edges, then the **i=mth "essential star branch's"actual polygon** move off the **i=(m-1)st "essential star branch's"actual j=2 polygon.**

b) At the $P2^{i=(m-1)}$ peak of the convex polyhedron: **originally** there is also **no edge cut,** so the polygons marching into this peak have the angle (sum of their plane-angle $\mathbf{alfa}_{P2}{}^{i=(m-1)} < 360°$; if at the unfolding process **one edge of** $P2^{i=(m-1)}$ **is indicating to cut,** this angle will be $\mathbf{alfa}_{P2}{}^{i=(m-1)} = 360°$. So each polygons marching into the $P2^{i=(m-1)}$ can be unfolded and will move off the polygon being in the cutting edge's other endpoint being the **k= 2nd** polygon of the **i=mth "essential star branch".** Thus we can state, that the joining edge between the **i=(m-1)st and i=mth** polygons, the $\underline{P1^{i=(m-1)}-P2^{i=m}}$ **winged edge has** both of two endpoints **cutting edge**, this way **the polygons** — earlier touched one another— being in $P1^{i=(m-1)}$ **and** $P2^{i=m}$ **will move off each other.**
Conclusion: On the base of the above mentioned **"proof with complete induction" that the polygons of** the Equatorial **one-rowed joined polygon-chain** —having **m** polygons marching E_W-> E_E— **can be unfolded to a plane, and at their cutting out edges the earlier touching polygons move off each other at all of the analysed convex polyhedrons.** ■
III) Affirmation: The polygons of the "essential star branches" chosen arbitrarily **move off each other** and form any earlier neighbouring unfolded polygons — **after the suitable edges cut at all of the finite convex polyhedrons.** In this main step **one had to be indicated to all of the "essential star-branches"** branching off the **E polygon-chain,** which were marching from **W**est to East: E_W -> $E_E \equiv E_W$ **(i=1,2,…,m).** At all of the **"essential star-branches"** we must apply **the proof with complete induction** from the **N**orth and **S**outh **Pole/CPi** backwards in the steps **j,k=n,(n-1),…,2,1** upto the **E Circle** or upto the **borders** of the next **"essential star branch"**/recursive **star-branch. This proof with complete induction can be** introduced **in II) case** may apply also to this **III) case** but with opposite direction. In this manner we proved **with complete induction at all of the one-rowed joined polygon-chains/essential star-branches,** that in their environment —unfolding the convex polyhedrons by cutting the suitable edges to half-edges,— **the polygons move off each other and all the earlier unfolded neighbouring polygons.** ■

6. SUMMARY

The author developed and introduced a modified winged edge structure solid body/surface modelling tool, which was applied by him for unfolding the surface of the finite convex polyhedrons. He gave an creative proof for the Dürer's conjecture pulished about 1525: "all the convex polyhedrons can be unfolded to a plane for a joined, non-overlapping polygon by their suitable cutting edges [Dürer, 1]. First O'Rourke at al. said, that this conjecture is true and they gave probably a proof in a creative way –as the author knows–about 1992 [O'Rourke, 9].

The author would like to draw attention to unfolding the concave polyhedrons and to the free form surfaces covered bodies, contained **p=3,4,..,6,…sided polygons/patches** to reach less overlapping and deformation during the unfolding process, which tasks are very important in the engineering applications.

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UNIVERSITY OF SZEGED
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